UNIVERSITY OF CALIFORNIA.

COLLEGE OF AGRICULTURE.

REPORT

OF THE

PROFESSOR IN CHARGE TO THE PRESIDENT,

BEING A PART OF THE

REPORT OF THE REGENTS OF THE UNIVERSITY.

1882.

SACRAMENTO:
STATE OFFICE . . . . . . JAMES J. AYERS, SUPT. STATE PRINTING.
1883.

UNIVERSITY OF CALIFORNIA.

COLLEGE OF AGRICULTURE.

I. C. Russell

REPORT

OF THE

PROFESSOR IN CHARGE TO THE PRESIDENT,

BEING A PART OF THE

REPORT OF THE REGENTS OF THE UNIVERSITY.

1882.

SACRAMENTO:
STATE OFFICE, ... JAMES J. AYERS, SUPT. STATE PRINTING.
1883.

TABLE OF CONTENTS.

REPORT

OF THE

PROFESSOR IN CHARGE TO THE PRESIDENT,

BEING A PART OF THE

REPORT OF THE REGENTS OF THE UNIVERSITY.

REPORT OF PROFESSOR E. W. HILGARD.

President W. T. Reid:

DEAR SIR: In response to your circular requesting suggestions regarding the "improvement and increased efficiency" of the department under my charge, I respectfully submit the points hereinafter noted, together with appendices embracing the results of the experiment station work carried on under my direction during the last two years.

The course of instruction in the subjects more directly related to agriculture has, during that period, been continued substantially as in the preceding years; the subjects of general as well as economic botany and agricultural chemistry being taught by myself, while the course of practical agriculture and special cultures has been given by Mr. Dwinelle, except only the subject of dairying, which has, as for some years past, formed the subject of a special course of twelve lectures by Mr. E. J. Wickson. In these courses the College of Agriculture has had its fair proportion of students among the scientific colleges.

It is nevertheless true that the numbers of those attending is very small in proportion to the predominance of agriculture as a pursuit. This is the case throughout the United States, and the causes leading to this state of things, which I have discussed in a late publication,* are such that, in my opinion, it cannot be remedied by any direct action in the organization of the college, consistently with its character of a professional school. The unexhausted soils as yet yield rich returns even to rude culture, and as a consequence, farmers do not generally appreciate the utility and need of the use of trained intellect and science in their industry. And yet there is in California a more remunerative field for the exercise of discriminating judgment, and the application of science, than is the case in any other State of the Union. Owing to the great diversity of climates and soils, and their adaptation to a great variety of cultures, yielding high returns on small areas, fruit, and especially grape culture, with the use of irrigated lands, impart a character of permanence to agricultural investment that is not usual in States as young as this; and hence the instability of the pioneer farmer is largely offset by the obvious interest of the owner of such valuable properties, to maintain their value, and to increase and improve their products to the highest extent possible. There is, therefore, a real demand for agricultural science, greater than in most States west of the Alleghany range. But it has not yet found its natural source of supply. To point this out, and to prove to farmers by actual demonstration the utility of the knowledge that the College of Agriculture offers to impart to their sons gratuitously, is, in my view, the most important function which, at the present time, that College can discharge.

*Atlantic Monthly for April and May, 1882.

1. EXPERIMENT STATION WORK.

In elucidation of these views, I cannot do better than to quote, in this connection, part of a communication addressed by me to Governor Perkins on this subject in May last:

In the effort toward the fulfillment of the practical objects contemplated by that Act, considerable diversity of opinion has prevailed, and has found expression in a corresponding diversity of organization in the colleges established in the several States. Without entering upon a discussion of these, and of their respective merits, it may be said that one point has made itself prominently felt in all, namely: the need of a detailed knowledge of the agricultural features and special adaptations of the States and their several agricultural subdivisions, and of the experimental investigation of the numerous practical problems that meet the farmer at every turn, and upon the solution of which so often depends the question of profit or loss, success or failure. While the performance of the work of agricultural surveys and experiment stations by the colleges is not directly prescribed as one of their functions in the fundamental Act, experience has shown it to be one of the most important means at their command for benefiting agriculture at the present time, not only by the actual demonstration of the best methods of treating soils and crops under endlessly varying local conditions, but also in showing farmers the advantages to be derived from an intelligent observation of facts, and from the application of scientific knowledge and principles to their pursuit, thus inducing fathers to give their sons the opportunity of acquiring such knowledge for themselves in the institutions created for that purpose. The experiment station work seems, at the present stage of our agriculture, to offer the most direct mode of benefiting both the present and the future generations, since attendance upon agricultural schools will always be small so long as the soil is unexhausted, and offers to the rudest tillage, for the time being, rewards nearly as great as those realized by the most intelligent culture. Such a state of things can, it is true, be only of short duration, even in the most productive regions; and where cultures and methods involving large permanent investments prevail—as is the case in the vineyards, orchards, and irrigated lands of California—ordinary business prudence leads men to foresee and endeavor to provide against the inevitable and disastrous consequences of irrational and exhaustive cultivation.

It is thus that, compared with other and much older States, California has a more vital and immediate interest in progressive and rational agriculture; the more as her varied climates and soils present endless and most attractive opportunities for varied cultures and industries. It is thus that the experiment station work carried on so far by the agricultural department of the University, although very limited in its means, has nevertheless attracted considerable attention, and has been able to throw light on many important practical questions, as may be seen from the three reports of work thus far published. Besides a general investigation of the soils of the State; of the nature and remedies for the "alkali," with which some regions are afflicted; of the nature and effects of waters serving or intended to serve for irrigation; analyses of fruits, materials for sugar making, of grapes, wines, and musts; there have been made on the grounds of the University extended culture experiments on the effects of various fertilizers and methods of culture on the cereal and forage crops, while at the same time a very large number of new varieties of these have been introduced from Europe and elsewhere, their adaptation tested, and seed of the more promising kinds distributed over the State. The same course has been pursued in regard to other culture plants, and the garden of economic plants shows in actual cultivation, for experiment as well as for demonstration to classes, most of the important cultivated plants capable of out-door culture in the coast climate. The propagating houses, so far as their capacity allows, show the same for plants requiring protection; but here, unfortunately, the limit of accommodation is already reached, and the space falls far short of the needs of the department, though a great deal of interesting material is on hand. During the last two years, a large number of species of forest trees, from the East, Europe, Asia, and Australia, have been grown from imported seed, and some of these, including the cinchona, with other plants, have

been distributed to intelligent persons in various parts of the State for trial. The University grounds are being utilized for the purposes of an illustrative and experimental arboretum, in which the adaptation of forest trees to the climate and for practical purposes will be tested. The investigation of noxious and beneficial insects, and of the means for repressing insects and other pests—such as the ground squirrel, for which an efficacious antidote has been found—is also in active progress.

It is, perhaps, needless to discuss the utility of these investigations toward the progress of agriculture and a knowledge of the resources of the State, which will be farther increased and diffused by the publication of an agricultural map of the State, now in course of preparation by myself, and soon to be issued by the census office. The utility would be greatly increased by the establishment of other experiment stations, located in representative localities in the several climatic and soil regions of the State, where local questions could be best investigated and determined, in coöperation with the central station at the University. To some extent this function has been performed by intelligent farmers in the various sections. But experimental work is, of necessity, expensive, and especially so where a great variety of operations is carried on on a small scale, as is the case at the University. The pecuniary benefits to be expected as their ultimate outcome will lie altogether outside of the experimental grounds, and at the present time the demand upon the department for information, investigation, and experiment has completely outrun its resources and the provisions made therefor by previous Legislatures.

In other words, I consider that the work of an agricultural experiment station, in which practical questions of all kinds that puzzle farmers in their daily pursuits, are experimentally determined and answered, is the key to the situation, so far as the utility and public appreciation of the College of Agriculture is concerned. I would, therefore, earnestly urge that the Board of Regents should, so far as in them lies, endeavor to maintain and foster this part of our work, and to provide for it the means needful to its successful and unhampered development. It is, at best, a very heavy addition to the regular duties of the instructors, which are nowise diminished by a small attendance of pupils. This additional burden has been voluntarily and gratuitously assumed, and cheerfully borne, so long as a satisfactory rate of progress could be maintained. It cannot, however, be expected that this should continue indefinitely, especially under the stress of inadequate means and the performance of mere routine work of a clerical nature, coupled with all the vexations incident to the accumulation of retarded work. If the work is worth doing at all, it is worth while to have it well and promptly done.

The appropriation asked by the Board of the last Legislature ($5,000 per annum) has, as I represented in my last report, proved entirely inadequate to the operations of the department, with the increasing demands made upon it, and the necessary increase of compensation for competent employés. For the present year, the work on the agricultural grounds has been altogether restricted to the maintenance of the permanent planting. The garden of economic plants is reduced to half its size and complement of plants, no sowings having been made except of such seeds as would otherwise have been lost. The distribution of seeds and plants has, of necessity, been almost entirely omitted.

In view of this discouraging state of affairs, I respectfully request that timely measures be taken toward securing from the next Legislature a reasonably adequate appropriation for the purposes of the experiment station work. Failing which, it would be preferable to discontinue it until the public sentiment of the State shall demand its revival, with adequate provision for its maintenance.

FUNDS REQUIRED.

As to the amount actually needed, I have made a careful revision of the expenditure during the year when the work was on the most satisfactory footing, viz., 1881. Making due allowance for the deficiencies that occurred even then, I find that the average pay-roll per month for labor and superintendence must be placed at about $335, or say $4,000 per annum. Add to this $1,800 for the salary of the regular lecturer on practical agriculture, Mr. Dwinelle, and $120 for the course in dairying, to which should be added another similar one on viticulture, making $2,040 for instruction. For clerical and other work, such as could be performed by students employed by the hour—preparing and writing labels, making up and dispatching seed packages, the stenciling of a number of additional diagrams imperatively needed in the lecture room, labeling and arranging collections, etc., from $300 to $400 per annum should be provided for. Add to this the much needed purchase of some additional implements, plows, roller, etc., repairs, shoeing of horses, the purchase and distribution of seeds and plants, postage, and miscellaneous expenses in the maintenance of the propagating houses and garden, and at least $1,000 will be required over and above. I therefore respectfully suggest that an appropriation of *not less* than $7,500 per annum, or $15,000 for two years, be asked of the next Legislature on behalf of this work. I feel quite sure that such a request would be heartily seconded by the enlightened agricultural sentiment of the State.

If the above estimate for labor on the experimental grounds of the University should seem too high, in view of the small area so occupied, I would call attention to the fact that not only does the multiplicity of small plots, which have at times numbered no less than 650, preclude almost entirely the current use of labor-saving implements, by which many times the area could easily be kept under cultivation if occupied by one or a few crops; but the kind of labor employed has to be of the best class, "extra hands," qualified and willing to carry out faithfully and in detail all instructions given, and to be trusted for exercising some judgment of their own in doubtful cases. In addition, the application of the "eight hour law" to our work adds materially to its cost over and above that done in a private establishment.

The report of Professor Dwinelle on the experiments in field cultures, made during the past two years, and on other matters germane thereto, forms Appendix No. 2 to the present report. Among the greatest needs of the experimental grounds is the laying of about 3,000 feet of underdrains, for the relief of some of the best portions of the lands which are now almost unavailable for experimental purposes on account of their excessive wetness in spring, and the washing away of the soil during heavy rains, destroying all comparison with adjoining plots differently situated. Professor Dwinelle's report gives some details and estimates in this connection.

The report of Mr. W. G. Klee, gardener in general charge of the experimental grounds, on subjects connected with horticulture and forestry, forms Appendix No. 3, to which is added a list of donations of seeds, plants, etc., received during the period covered by the present report.

2. LABORATORY WORK.

In connection with this work, the employment of a competent laboratory assistant is of the utmost importance. I have in previous reports called attention to the undesirable state of things in this respect, which virtually makes of the working laboratory a training school for analytical chemists, who in a year or two find more profitable employment, and thus compel the biennial repetition of the breaking in of a raw hand. This is a grave drawback upon the work, involving practically the loss of at least six months time in actual progress as the result of every such change; but also affects its quality, and for the time being is a heavy burden in addition to the regular and irregular duties of the department. A graduate of good ability will serve one, or possibly two years, at the low compensation now allowed (fifty dollars per month), for the sake of learning, but in order to retain him an increase of pay to at least seventy-five dollars per month is necessary after that. If such increase cannot be afforded out of the University funds, an allowance for that purpose should be made in the estimate of the appropriation for experiment station work, of which this position forms an indispensable part. At the present time, the resignation of Mr. M. E. Jaffa, from the causes just recited, leaves the department without a chemist, and for the time being without an acceptable candidate for that position. Numerous requests for information, the replies to which involve some chemical work, are on file, but cannot be acted on.

A record and discussion of the laboratory work done since the last report was made, forms Appendix No. 1 to this report. It refers largely to the investigation, classification, and mapping out of the soils of the State, and with that end in view, the soil analyses heretofore made and reported upon, are re-introduced for the sake of completeness and comparison. Among the analyses are twelve of soils belonging to districts in which cotton culture may hereafter become a prominent industry, and which for that reason were selected by me for investigation in connection with the census report on the cotton production of the United States. The soils so analyzed under the auspices and at the expense of the census office, are introduced here by permission of the Superintendent of the Census, and marked by an asterisk (*). They were mostly collected by myself personally, while traveling during the recesses of the University, under the auspices and at the expense of the census office, with a view to the construction of a soil map to accompany a report upon the agricultural features of that part of the State adapted to cotton culture, which will be published during the coming year.

3. VITICULTURAL WORK.

The work in the viticultural laboratory, provided for by an appropriation of $3,000, made three years ago by the Legislature, has been continued (with occasional interruptions in favor of field work on behalf of the Viticultural Commission) by Mr. F. W. Morse, who has been for some time past engaged in the elaboration of the results elicited by the work on the vintages of 1880 and 1881, as well as on samples furnished by wine makers in different parts of the State. The report on this subject forms Appendix No. 4 to the

present communication, and will be found to embrace a good many important facts and suggestions in connection with the wine industry in this State. In the nature of the case, however, such investigations applied to only two crops, and a few only of the more prominent grape varieties, can merely serve to point out the way to farther prosecution of the research; as is always and unavoidably the case in agricultural investigations, where hasty conclusions are very apt to be upset by continued experience. The fund for this purpose is now exhausted, and unless the continuation of the special work is provided for by a renewal of the appropriation, it can hereafter only receive its proportionate share of attention among the other experimental work. This would be the more unfortunate, as the special practice and skill in this direction acquired by Mr. Morse, could not be commanded under the arrangements now in force in respect to the assistant in the general agricultural laboratory. In view of the slight running expenses, now that the laboratory and cellar are fitted up for work, an appropriation of $2,000 for the two coming years would suffice to provide for the continuation of these very desirable investigations.

4. INSTRUCTION IN BOTANY.

It will be remembered that six years ago I took charge of instruction in botany, finding that course indispensable as an attractive introduction to the more strictly professional studies in my department. The result has, I think, justified my views in the matter; but, at the same time, the somewhat exacting nature of the botany course has compelled me, as a matter of physical necessity, to abridge greatly the course of agricultural chemistry. This is unfortunate as involving the properly fundamental study of the agricultural course, and is a source of complaint on the part of the special students. It would be exceedingly desirable to place at least the first part of the botany course, and preferably the whole, in the hands of a competent specialist, whether as a lecturer or a permanent chair of botany, such as exists in nearly all other colleges, based upon the Morrill grant. The course of agricultural chemistry, extended to its legitimate scope, coupled with the duties of the experiment station work, would afford ample and very important occupation for myself, and a somewhat excessive strain from lecture duties, under which my health has been imperiled, would be measurably relieved.

5. INSTRUCTION IN GENERAL AND ECONOMIC ENTOMOLOGY

Is clearly called for by the exigencies of the situation as regards insect pests in the State. The demand for information has caused Mr. Dwinelle to give considerable attention and time to the subject during the past year, and to give regular hours, outside of those called for by his regular engagement, to elementary and general instruction, and discussion of specially important groups, with the Senior class—the study having been made obligatory upon students in the agricultural course, by action of the Faculty. But the subject clearly demands such time and detailed study as can only be given it by a specialist, and I earnestly suggest that the attempt to obtain an endowment for a chair of general and economic entomology, made at the last session of the Legislature, be strenuously renewed at the coming session. Any efforts made by the Regents in this direction

will be strongly seconded by the fruit-growing and general agricultural interests of the State, who are fully alive to the importance of a timely repression of the danger threatening some of our most important industries from the increase of noxious insects. The legislation now in force has prepared the way for what is obviously needed, systematic investigation and instruction in economic entomology. The donation recently made to the University, of a valuable collection of beetles, forms both a good beginning for instruction and a proof of the appreciation of the importance of farther steps to be taken in this matter. Professor Dwinelle's active participation in the war against noxious insects, as President of the State Board of Horticulture, has in addition to its practical usefulness, served to extend the appreciation of the work of the University in coöperating with all efforts for the benefit and improvement of agriculture in the State.

In conclusion, I beg leave to call attention to the fact that the matters mentioned under numbers two, three, four, and five, lie outside of the scope of the appropriation of $15,000 recommended for the general work, and would require additional funds to be carried into effect.

Very respectfully,

E. W. HILGARD,
Professor of Agriculture and Botany.

BERKELEY, August 1, 1882.

APPENDICES.

APPENDIX I.

REPORT AND DISCUSSION OF WORK IN THE AGRICULTURAL LABORATORY.

BY E. W. HILGARD.

INVESTIGATIONS OF CALIFORNIA SOILS.

As stated elsewhere, a large share of time and attention has, during the past two years, been given to the examination of the soils of the State, both as to their distribution and their chemical and mechanical composition. A few investigations of this character have been published in previous reports; but the means at the command of the Department have not permitted any systematic investigation of the subject as regards the State at large. Some steps in that direction were taken in 1880, at my suggestion, by the Census office, in connection with the preparation of a report on the adaptation of California to cotton culture, as part of the general report on the cotton production of the United States. The timely aid thus given has enabled me, not only to obtain representative soil specimens from the chief soil regions of the State, and to subject some of the more important to analysis, but also to visit personally or by deputy, portions of the State with which I was heretofore unacquainted, and regarding which no definite data were obtainable. Of the soils hereinafter mentioned, those marked with an asterisk have been analyzed at the expense of the Census office; while the rest were taken in the course of the regular work of the Department on the agricultural features of the State. For the sake of comparison and completeness, the analyses heretofore made by the Department and published in previous reports, are reintroduced in the present one, and all are connectedly shown on Table "I."

The view thus afforded of the character of the soils of the State, however fragmentary, gives high testimony of their native fertility, and contrasts curiously with similar presentations of the soils of some of the Atlantic States, obtained in the work of the census of 1880.

SOIL REGIONS.

For the purpose of convenient discussion, the soils analyzed are placed under the heads of the agricultural regions to which they

severally belong. The subdivisions adopted for the present are th following:

1. Sacramento Valley.
2. San Joaquin Valley.
3. Foothills of the Sierra.
4. Southern or Los Angeles region.
5. Coast region south of San Pablo Bay.
6. Coast region north of San Pablo Bay.

In each of these regions there are, of course, numerous mino subdivisions and soil-varieties. But the material thus far at hand i not sufficient to define many of these, and hence they will receiv only cursory mention here. A more exhaustive discussion of th soil features of the State will appear in the reports of the census for 1880.

1. SOILS OF THE SACRAMENTO VALLEY.

The soils of the Sacramento Valley are as yet but very inadequately represented by the subjoined analyses, the material on hand being too limited to allow of selecting advisedly representative samples. Nos. 563 and 110 are probably of wide applicability, and Nos. 517 and 561, taken together, may also probably be taken to be fairly representative of the loam of the east side of the valley. Of the true "adobe" of the valley, no analyses have thus far been made.

No. 563. Sediment soil, from near the banks of the Sacramento River, on Rancho Chico, General Bidwell's land, Butte County. A gray or dun powdery loam, with but little coarse sand, very easily tilled, and the same to a depth of several feet; sample taken to the depth of twelve inches. Well timbered with white oak (*Q. lobata*), ash, sycamore, with abundance of grapevines. Very productive in cultivation.

No. 561. Dark "adobe" loam soil, from the Rancho Chico, about a mile east from the Sacramento River, where No. 563 was taken. Dark tinted, moderately heavy, so that after drying it can still be crushed between the fingers; taken to the depth of twelve inches; becoming paler colored below that depth; originally treeless, bearing a growth of sunflowers and alfilerilla. Not as regularly or highly productive as the river land.

No. 517. Reddish soil, from near Biggs' Station, Butte County. A clay loam, brownish dun in color when dry, brownish black when wet; dry lumps are hard to crush between the fingers, but soften quickly on contact with water. This soil occupies a level belt, lightly timbered with oaks, to eastward of the adode belt of this region. Between the two there intervenes, usually, a streak of whitish soil, from which there is a gradual transition to the true adobe.

No. 656. "Slickens" or fine mining debris deposit, from Yuba River, Yuba County. Sent by the Secretary of the "Debris Committee," of the City of San Francisco. Light yellowish-gray, partly in powder, partly in chalky lumps, easily crushed, very light, scarcely palpable; emitting a strong clay odor when breathed upon or wetted.

No. 1004. "Slickens" sediment, from Alger's Bend, Feather River, Butte County; furnished by Mr. Julian Le Conte, of the United States River and Harbor Survey. A compact, yellowish-brown lump, somewhat heavier than No. 556; can be crushed between the fingers with little difficulty to an altogether impalpable powder;

mits a strong clay odor when breathed upon or dampened. The
eposit is stated to have been six to eight feet in thickness in the bed
f the river, and upon drying, forming wide-gaping sun-cracks,
llowing a man to walk between the blocks, on a base of sand; when
eposited it must have been almost in a gelatinous condition.

No. 10. Sediment soil, from the farm of Mr. Daniel Flint, on the
acramento River, a few miles below Sacramento City, Sacramento
ounty. Deposited during high water, and said to exert a remark-
ble effect in increasing the productiveness especially of clay land
pon which it may be brought. It is a light, buff-colored silt, almost
mpalpable when rubbed between the fingers, and without sand or
ravel.

**No. 110. Soil of Putah Valley,* near Dixon, Solano County, sent by
. M. Dudley, from the "middle land" of the plain, on the slopes of
he swales, about three feet above the lowest land.

SOILS OF THE SACRAMENTO VALLEY REGION.

	Butte County.						Yuba County.		Butte County.		Sacramento County.		Solano County.	
	No. 563. S. 27, T. 22, R. 1 W., Sacramento River Alluvium, Rancho Chico.		No. 561. Black Loam Soil, Rancho Chico.		No. 517. Brownish Loam Soil, Biggs' Station.		No. 656. "Slickens" from Yuba River.		No. 1,004. "Slickens" Sediment, Alger's Bend, Feather River.		No. 10. Sediment Soil, Sacramento River.		No. 110. Putah Valley Soil, middle land.	
Insoluble matter	70.764	73.444	59.144	62.304	63.268	68.018	72.169	75.240	61.029	69.062	55.283	69.223	67.334	71.005
Soluble silica	2.680		3.160		4.750		3.071		8.033		13.940		3.670	
Potash		.652		.305		.453		.267		.300		.353		.929
Soda		.077		.221		.113		.025		.124		.065		.124
Lime		1.444		2.909		1.460		.794		.521		.901		.770
Magnesia		2.277		1.042		2.174		.866		.768		1.249		2.285
Br. oxide of manganese		.015		.025		.105		.025		.089		.111		.106
Peroxide of iron		5.804		9.342		8.585		6.582		6.586		6.316		8.011
Alumina		10,397		13.038		12.045		10.390		14.229		15.251		9.159
Phosphoric acid		.087		.095		.064		.076		.078		.250		.111
Sulphuric acid		.030		.068		.047		.134		.067		.097		.120
Carbonic acid														
Water and organic matter		5.351		10.149		6.701		5.716		8.024		6.751		7.115
Total		99.578		99.498		99.765		100.115		99.848		100.567		99.735
Hygroscop. moisture absorbed at		6.84		13.980		8.29				10.09				10.315
		11.5° C.		13°		13° C.				15° C.				15° C.
Humus		.749				1.184								1.709
Available inorganic		.255				.464								.562

The common characteristic of all these soils is an adequate, and, in some cases, generous supply of lime, which insures the availability of the plant food they contain, greatly enhances their power of resisting drought, of forming and retaining humus, and renders them easily tillable, notwithstanding the large amount of clay they contain. This feature, as will be seen hereafter, characterizes, to a greater or less extent, most of the soils of the great valley, from Redding to Bakersfield, and it is with constant reference to it that their agricultural qualities must be considered.

Passing to the other primarily important ingredients of plant food, we find that in the alluvial soils proper—as in that from Dixon, and from the Sacramento, near Chico—the amount of potash is large; in the former case even very large. Away from the river this ingredient diminishes, in the case of the Rancho Chico, to one half of what it was near the river; the deficiency being partly offset by a very large supply of lime in No. 561, which manifests itself in its dark tint. In the soil from Biggs' Station, the tint of which indicates a partial derivation from the red materials of the foothills, the potash supply is more ample.

In none of these soils, however, is the supply of phosphates a large one. In the soil from Biggs' Station, but for the presence of a liberal amount of lime, it would be accounted deficient. Whenever their production shall have been materially diminished by exhaustive cultivation, the use of phosphate fertilizers will evidently be the first thing needful to restore productiveness.

Nos. 656 and 1004 may be considered as fairly representative of the composition of the finest material, or "slickens," brought down from the hydraulic mines by the Feather and Yuba Rivers, and deposited in their back or slack waters. A comparison of their composition with that of the above soils, shows that they do not differ very widely in their mineral ingredients, as might be foreseen from the community of their origin. Their potash percentage is low, yet not lower than that of some good soils. The lime percentage, while lower than in the Sacramento alluvium, is reasonably high, and the supply of phosphoric acid, while not large, is only little below the average of the soils analyzed. It may be expected, therefore, that whenever these "slickens" soils shall have been subjected for an adequate length of time to the same agencies that have been active in the natural alluvial soils, they may become equally productive. As they are, however, they lack a high essential of all agriculturally valuable soils, viz.: the humus or vegetable mold, whose physical as well as chemical action is so important to the welfare of plants, that popular belief has long ascribed to it a controlling influence on fertility. And although we now know that humus is but one of the many factors that contribute to the productiveness of soils, we also know that, practically, its deficiency or absence is an effectual bar to profitable culture. Under the climatic conditions of the Sacramento Valley, it will take many years to remove this disability in the natural course of things. The process may be hastened by the operation of green manuring, provided green crops can be grown on the material; and this will, in general, be the most important step towards the reclamation of tracts covered by "slickens."

It is hardly necessary to advert to the fact that the material of the debris, brought down from different channels and at different times, may vary indefinitely; from cobblestones through gravel and sand to

the finest matter graphically designated as "slickens," and according to the sources from which the latter come, the chemical composition will also vary locally. Moreover, when a coat of moderately sandy material is deposited on adobe land, the intermixture of the two by the plow may oftentimes result in a material improvement in consequence of the removal of the extreme mechanical intractableness of the clay land. In other cases, a local deposit may be exceptionally rich in some important ingredient, and may thus serve directly as a fertilizer when applied to cultivated land. Analysis No. 10 shows a case in point, in which a deposit on the banks of the Sacramento River is so rich in phosphoric acid as to be available as a fertilizer on the adjacent alluvial lands. Some of the effects observed may, it is true, be due to the improvement of the mechanical condition also.

It cannot therefore be surprising that the testimony as to the local effects of "slickens" on land overrun by it, should vary considerably, according to the circumstances of the case. Cobblestones and gravel will in every case be considered an unmitigated detriment. A moderate coat of a sand spread on an adobe tract may be welcomed at first; but its repetition will naturally be objected to, and a deposit of any considerable thickness will effectually spoil the land forever. So also, a moderate coat of "slickens" will, on the low and heavy lands on which it is most widely deposited, be at first a benefit, as improving the tilling qualities of the land; and finding a sufficiency of humus in the soil, its fineness will cause it to be promptly acted upon and utilized as a source of plant food. But whenever the dose is repeated the advantage diminishes, and finally changes to a very positive detriment, so soon as the "slickens" becomes the predominant ingredient of the cultivated soil; while a thick deposit coming *at once* will, for the time being, and usually for many years to come, deprive the farmer of the profitable use of his land, albeit it may become profitable to his children or grandchildren.

Such I consider to be the impartial view of the "slickens" question, independently of that of obstruction of channels and consequent overflows, the consideration of which lies outside of the province of this report.

2. SOILS OF THE SAN JOAQUIN VALLEY.

The soils of the southern division of the great valley differ quite materially and characteristically from those of the Sacramento Valley. In the latter, we have fine-grained alluvial loams, alternating with extensive streaks of heavy clay or "adobe" land. The soils of the San Joaquin Valley, on the contrary, are predominantly of a sandy character, the sand being sometimes quite coarse. South of French Camp Slough, near Stockton, the true black "adobe" occurs only in comparatively narrow bands, immediately along the present streams or tule lands; and what is popularly designated as "adobe" in the southern part of the San Joaquin Valley, can often be so considered only by courtesy, in comparison with the extremely sandy soils alongside.

Again, in this valley there is mostly a more distinct subdivision of the valley lands into upland or "bench" lands, and lowland or alluvial lands proper. The Stanislaus, Merced, and other rivers, after entering the great valley, meander in more or less extensive valleys

of their own, which are often bordered by rather abrupt bluffs from forty to fifty feet high, falling off from rolling plateau lands abutting rather abruptly against the foothills of the Sierra. These plateau or "plains" lands have frequently a curiously carved surface of little hillocks, from ten to thirty feet across and from one to three feet high, closely dotting the surface, with only little drainage channels between, which are commonly floored with some gravel, or, at times, with cobble-stones, washed out of the subsoil. This hillocky land is popularly designated as "hog-wallows;" but the name does not properly designate a particular kind of soil (save locally), it being in some cases a heavy, gravelly clay, in others very sandy, though perhaps predominantly the material is of a loamy character, with a tendency to the formation of "hardpan." When the latter is somewhat pronounced, it renders the smoothing down of the surface for convenient cultivation rather troublesome.

In the descriptions and tables given below, the soils are segregated into upland and lowland soils for convenience of consideration; but it must be admitted that the distinction is often somewhat arbitrary. Again, the two first mentioned (adobe soil and subsoil from Stockton), are much more closely related to the soils of Sacramento Valley than to those of the San Joaquin, the characteristic sandy soils beginning some miles to southward of the City of Stockton. True black adobe is, nevertheless, found again near and northeastward of Merced City.

A. Alluvial or Lowland Soils.

No. 6. Black adobe soil, from S. 45, Weber Grant, near Stockton, now the property of D. A. Learned, San Joaquin County. This soil is dark-colored, very adhesive when wet; in drying, cracks open to the depth of several feet at times. The sample was taken to the depth of twelve inches, soil remaining same. Its thickness varies from six inches to four feet, the latter coming nearest its average depth. The main body of this land lies between French Camp Slough on the south and the Calaveras River on the north, extending two miles beyond the latter; westward it reaches to the alkali lands bordering the tules, while its eastward limit is not well defined, but lies at least ten miles to the eastward of Stockton. The wheat product of this soil when fresh, averages between fifteen and twenty bushels per acre for five to eight years, then decreases, but can be brought up by summer fallow and good cultivation.

No. 7. Hardpan subsoil of No. 6. Found at varying depths underlying the black adobe in the lower ground, and is itself of varying thickness, from six inches to several feet. A yellowish or whitish-gray, moderately coherent mass, more or less porous; effervesces with acids, leaving a loose mass of sand and silt.

No. 195. Valley soil, from a valley two miles south of Merced River, Merced County, on the Hopeton and Merced Road, through which the ditch passes. A blackish-brown loam, easily tilled, and fairly representative of the soils of the smaller valleys of this as well as of the Dry Creek region.

**No. 198. Bottom soil of Merced River,* from J. A. Grade's cotton plantation, near Hopeton, Merced County. A dark-colored, light loam soil, varying in depth from eighteen inches to five feet, according to location; usually underlaid by gravel, which undulates more or less in subterranean ridges. Its chief natural growth is the California sun-

flower, growing very luxuriantly; some oaks and cottonwood on the lower ground. The bottom here is about four miles wide from bluff to bluff, and is traversed by numerous sloughs as well as by gravel ridges. This soil in good seasons has made over twelve hundred pounds of seed cotton per acre; a large body of it constitutes the Strong, Grade, and Buckley ranches, where cotton has been successfully grown for many years.

**No. 701.* "*Dry bog*" *soil*, from a valley on Sisson, Wallace & Co.'s land, six miles northeast from Visalia, Tulare County, in the "hog-wallow" hills. A black, heavy soil, occurring in the smaller valleys among the "hog-wallow" land. It is chiefly covered with long grass during the growing season, and like the "adobe" elsewhere, is often deeply fissured during the dry season. It has, usually, at a depth varying from six to eighteen inches, a subsoil of heavy gray clay, with spots and concretions of bog ore, or "black gravel;" hence it is commonly ill-drained and needs drainage first of all. But little of it is cultivated. The analysis was made to determine its value for permanent culture when reclaimed.

**No. 585.* "*Wire grass soil*," from wooded flats, two miles west of Visalia, Tulare County. The soil is gray, or blackish, moderately heavy loam, characterized by a growth of wire grass (*Scirpus*), and more or less alkali grass (*Brizopyrum*), with alfilerilla, well timbered with oak. In low places, occasionally a little alkali is visible on the surface, but there is not enough of it in the land to prevent the growing of cereals or other crops, and it is highly productive.

**No. 570.* "*Brown adobe*" *soil*, from the lower land in the Eisen Vineyard, near Fresno, Fresno County, taken to the depth of twelve inches. Reddish brown, only moderately heavy, with much coarse sand intermixed; easily tilled, except when very wet. This soil may be considered representative of the more substantial soils formed by the foothill creeks between King's and the San Joaquin River, in their shallow valleys, separated by divides of "sandhill" ridges with very sandy soils.

**No. 579. Alluvial loam soil*, from near Grangeville, in the Mussel Slough country, Tulare County, and fairly representative of the best class of soils, yielding forty-six bushels of wheat per acre; quite light, and easily tilled, and no change of color for from eighteen to twenty-four inches; sample taken to the depth of twelve inches.

No. 77. "*Dry bog soil*," from the banks of Tulare Lake, near its southeast corner, from overflowed land reclaimed by E. R. Thomason. A full account of this soil and its peculiarities is given in the report of the Department for 1879, pp. 27 and ff. This soil rivals, in native fertility, the famous "buckshot" soils of the Yazoo Bottom, of Mississippi, but the alkaline salts contained in it, and derived from the waters of Tulare Lake, effectually prevent the growth of crops in its present condition. It is probably representative of a very large area of land laid dry by the recession of the waters of Tulare Lake, and whose reclamation would open to cultivation one of the most productive soil areas in the State.

SOILS OF THE SAN JOAQUIN REGION—ALLUVIAL OR LOWLAND SOILS.

	San Joaquin County.		Merced County.		Fresno Co.	Tulare County.			
	No. 6. Black Adobe Soil, Stockton.	No. 7. Hardpan, subsoil of Adobe, Stockton.	No. 195. Bottom Soil.	No. 198. Bottom Soil, Merced River, Hopeton.	No 570. "Brown Adobe, Eisen Vineyard."	No. 701. "Dry Bog" Soil, "Hog-wallows."	No. 585. "Wire-Grass" Soil, Visalia.	No. 579. Alluvial Soil, Mussel Slough.	No. 77. "Dry Bog" Soil, Tulare Lake.
Insoluble matter Soluble silica	72.058	64.903	75.405 8.286 } 83.691	73.120 3.882 } 77.002	76.622 2.870 } 79.492	67.519 4.259 } 71.878	66.470 4.950 } 71.420	79.518 3.219 } 82.737	67.34
Potash	.396	.248	.423	.569	.714	.552	1.224	0.700	1.05
Soda	.479	.404	.125	.094	.444	.657	.677	286	.84
Lime	1.927	8.502	.758	1.316	1.769	2.599	3.043	1.246	6.51
Magnesia	1.640	2.700	.621	.547	2.048	.799	.087	1.578	3.96
Br. oxide of manganese	.056	.034	.038	.036	.041	.066	.030	.018	.04
Peroxide of iron	6.815	5.672	4.452	9.078	3.728	5.624	5.823	4.030	5.05
Alumina	11.620	6.252	6.331	5.090	7.988	12.390	7.137	6.578	7.97
Phosphoric acid	.179	.324	.048	.132	.038	.074	.239	.069	.32
Sulphuric acid	.037	.056	.046	.094	.074	.145	.655	.019	.08
Carbonic acid	------	6.229	------	------	------	------	2.546	------	4.42
Water and organic matter	5.871	4.860	3.882	5.991	3.244	4.555	7.091	3.049	3.71
Total	101.078	100.184	100.415	99.949	99.580	99.339	99.972	100.310	101.29
Hygroscop. Moisture absorbed at 15°C.	------	------	5.48	5.671	5.430	11.194	8.530	3.889	------
Humus	------	------	0.867	1.800	0.597	1.061	------	.644	.468
Available Inorganic	------	------	0.595	0.563	0.373	.984	------	.578	2.184

B. Upland or Bench Soils.

**No. 193. Loam soil,* from the "hog-wallow" tract five miles north of Merced City, Merced County, near Huffman's wheat farm; a reddish or brownish loam, rather close and coherent when dry; sample taken to the depth of twelve inches; subsoil nearly of the same character for three feet. The surface of this land lies in gentle swells, on which are the characteristic "hog-wallow" hillocks, not very deeply impressed, and therefore not interfering materially with plowing, even in fresh land: almost disappearing after a few years' tillage. Wheat product, twenty-five to thirty bushels per acre, in fair years, on fresh land.

**No. 704. Fresno Plains soil,* from Mr. White's place, Central Colony, about two miles south of Fresno City, Fresno County. A grayish-white, somewhat ashy soil, changing little to the depth of two feet or more, then gradually becoming more sandy; sometimes underlaid at from one and a half to three feet depth, by a sheet of calcareous hardpan, eight to eighteen inches in thickness, that seems to be merely the subsoil cemented by lime. In planting trees it is sometimes necessary to break through this hardpan in order to enable the roots to reach moisture. This soil is said to be fairly representative of the country lying to southward and westward, toward King's River, and the San Joaquin. To the east and north it passes into the reddish and "sandhill" soils, formed by the streams coming from the foothills. (See soil No. 570, from the Eisen vineyard.)

**No. 586. Tulare Plains soil,* taken midway between "Outside Creek" and the Sierra foothills, east of Visalia, Tulare County. Depth taken, twelve inches, with little change, apparently, for several feet. The tract is quite level, treeless; the land does well when irrigated, but has thus far been taken into cultivation less freely than the lands lying nearer the creeks. It is said to be a fair sample of the "plains" proper of this part of the San Joaquin Valley; of a dun color, quite light and sandy, and not altogether promising looking, but bearing a luxuriant growth of wild flowers, which testifies to its productive capacity.

**No. 573. Tulare Plains soil,* from near the crossing of Cross Creek, on the Visalia and Hanford road, Tulare County, taken to twelve inches depth. Resembles the preceding, but is of a more grayish tint when dry, and darker colored when wet, as a result of its proximity to the creek, which, however, rarely carries water, so that the soil can hardly be accounted an alluvial one. There are decided indications of alkali in the lower portions, and this is more clearly perceptible where the soil has been cultivated with irrigation, as is the case within a mile or two farther to the west. The country is altogether treeless, but in spring-time bears a luxuriant growth of bright flowers.

**No. 700. Salt-grass soil,* forming a belt on the western edge of the plains east of Buena Vista Slough, Kern County. A yellowish gray, fine sandy soil, nearly the same to a depth of several feet; sample taken to twelve inches; much salt-grass, and but little herbaceous vegetation beside. When irrigated this soil produces as much as forty bushels of corn to the acre. It has been but little cultivated thus far, being chiefly pastured.

SOILS OF THE SAN JOAQUIN REGION—UPLAND OR BENCH SOILS.

	Merced County.	Fresno County	Tulare County.		Kern County.
	No. 193. Loam Soil "Hogwallows."	No. 704. Fresno Plains Soil, Central Colony.	No. 586. Plains Soil, Outside Creek.	No. 573. Plains Soil, Cross Creek.	No. 700. Salt-grass Soil, Buena Vista Slough.
Insoluble matter	80.328 } 84.673	85.874 } 88.579	73.774 } 77.265	66.079 } 69.457	87.060 } 89.040
Soluble silica	4.345	2.705	3.491	3.378	1.980
Potash	.347	.340	1.221	1.817	.492
Soda	.058	.248	.149	.436	.305
Lime	.508	1.163	1.173	4.307	1.198
Magnesia	.588	.499	1.751	1.585	1.069
Br. oxide of manganese	.016	.034	.027	.078	.025
Peroxide of iron	4.772	3.276	5.673	6.041	5.822
Alumina	6.165	3.221	7.799	8.692	.171
Phosphoric acid	.023	.097	.103	.138	.079
Sulphuric acid	.006	.117	.003	.263	.133
Carbonic acid				2.533	
Water and organic matter	3.278	1.789	4.351	4.150	1.130
Total	100.434	99.368	99.515	99.497	99.484
Hygroscop. Moisture absorbed at 15° C.	4.212	2.217	4.618	8.735	2.164
Humus	.367	.604	1.139	.996	.170
Available Inorganic	.334	.351	.535	.740	.195

A glance over the above tables of soils of the San Joaquin Valley shows at once, that like those of the Sacramento division, they nearly all agree in having a large percentage of lime; in only one case as little as half of one per cent, in most cases over one, and ranging as high as three per cent.

All these soils are of rather a sandy or light character. This places them the more distinctly into the class of calcareous soils, and this accounts for the extraordinary thriftiness of even such as do not show a high percentage of phosphates and potash, when placed under irrigation. Thus, in No. 193 (Merced hog-wallow soil), the potash percentage is quite low for California, while phosphoric acid is exceedingly low. Yet these soils have yielded from sixteen to twenty-five bushels of wheat per acre for several years consecutively. They will doubtless, however, soon require the use of bone-meal for the maintenance of production. The same deficiency of phosphoric acid occurs in the bottom soil, No. 195, also from northern Merced. Almost throughout, the percentage of phosphoric acid in the soils of the San Joaquin Valley is only moderately high, many falling below one tenth of one per cent, and only two rising above two tenths. These are Nos. 585 and 77, both alkaline soils, in which, doubtless, the soluble phosphates have accumulated near the surface (from which the sample was taken), doubtless in part, at least, at the expense of the surrounding uplands. It follows, that while in the lowlands more or less impregnated with alkali, both potash and phosphates are comparatively abundant, and will not require replacement for a long time to come, the phosphates will be the first to become exhausted in the uplands; when bone-meal and superphosphates will come into heavy demand. On the other hand, the use of lime as a fertilizer will scarcely ever be called for in the San Joaquin Valley, and potash manures will not be needed for a long time to come, even in the uplands, and never in the lowlands.

It is important to note this corroboration of the opinion expressed in a previous report as to the superior value of the "alkali soils" when once properly reclaimed, and cultivated with a view to the repression of the "rise of the alkali" to the surface; for we find that with the worthless or injurious excess of salts there is almost always associated a large supply of soluble or at least available plant food, which will render these soils remarkably durable and thrifty.

For the discussion of the measures and precautions needed for the reclamation of alkali soils, the reader is referred to the report preceding the present one; also, to the "Report of the Commission on the Arid Region of the United States," lately published by the United States Department of Agriculture.

There is another point worthy of note shown in these analyses. The traveler on the San Joaquin plains will, during the dry season, imagine that the gray dusty soil of the plains is destitute of, or at least, very poor in humus or vegetable mold. The figures given in the table show that this is far from being the case, for even the white soil of the Fresno plains shows six tenths of one per cent, and that of the sandy Tulare plains, one per cent and over. It is here, again, the lime, so abundant in these soils, that helps to retain the humus, despite the prolonged action of the hot Summer's sun. Of the soils examined, two only are really deficient in humus, viz.: No. 193, Merced hog-wallow, and No. 700, the salt-grass soil of Kern. In the case

of the latter, the alkali present dissolves the humus, and allows it to be washed away into the sandy subsoil below, and this happens more or less in all alkali soils containing much carbonate of soda. It is, therefore, doubly important that this ingredient should be got rid of by the use of gypsum when such soils are put under cultivation, especially with irrigation.

In the case of the Merced hog-wallow soil, the poverty in humus is obviously attributable to its "hardpan" nature, through which, in its natural condition, the mold remains on the surface, and is "burnt out" by the sun during the dry season. The thriftiness of such soils would doubtless be very much increased by plowing under some green crops.

As to retentiveness of moisture, there are but two soils in the list below the limit usually deemed desirable. One of these is the white plains soil from south of Fresno (No. 704), and the salt-grass soil (No. 700), from Kern. The latter is notably deficient both in humus and clay, and what moisture it does retain is probably partly due to the alkali present. In the Fresno soil, considering the amount of alumina shown in the analysis, and the humus present, the moisture absorption is unexpectedly low, and in urgent need of being raised by means of green manuring. It will also be especially advisable that wherever there underlies the crust of hardpan at a depth less than three feet, that impervious layer be broken up or through, in order to enable the roots to seek for moisture at the depths allowed them by this very easily penetrable and deep soil.

This great depth of soil, which is observable more or less over the whole of the San Joaquin Valley, is of the utmost importance with respect to the permanence of productiveness; for, the soils being mostly very pervious and loose, and the water-table, even where irrigation is practiced, quite low, the plant is enabled to draw for its food upon a much greater mass of soil than would be the case where the latter is heavier and perhaps richer in plant food, but less easily penetrated by the roots than sandy soils are. In the case of the San Joaquin soils, moreover, examination shows that much of the sand is not quartz, but pulverized rock still in process of decomposition and soil formation.

3. FOOTHILLS SOILS.

[The hilly lands lying at the western base of the Sierra Nevada, and not too broken or elevated for cultivation, are popularly designated as "the foothills." They vary considerably in width, say from five to fifteen miles, the average being about twelve. They are usually timbered with a variety of oaks, also nut pine, buckeye, and manzanita; and their soils, mostly of deep orange tint, are directly derived from the country rocks.]

No. 559. Red loam soil, from near Redding Station, Shasta County; moderately heavy, red clay loam, with some gravel, and but little coarse sand; probably somewhat heavy in tillage, unless when just in the right condition. Collected by Mr. N. J. Willson, of the Central Pacific Railroad. No notes regarding this soil have reached me, but it is stated to be the representative soil of the region around Redding.

No. 705. Red chaparral soil, from a few miles west of Anderson, Shasta County; sent by Mr. George A. Moore, of Anderson, who

states that this land is covered with a dense thicket of chaparral (*Ceanothus*) and poison oak, with some small oaks and other brush. Taken to twelve inches depth. It is of a deep orange-red tint, and quite heavy and cloddy when dry; the lumps not to be crushed with the finger, but softening readily with water, and then showing a considerable amount of coarse sand to be present.

No. 706. *Subsoil* of the above, taken from twelve to twenty-four inches depth; similar in aspect to the soil, but more clayey and less tractable, but the clods also softening when wetted. Mr. Moore says that "about four feet from the surface there is such a compact mass of clay and gravel that water does not penetrate over fifteen inches from the surface."

No. 499. *Red upland loam soil*, from near Wheatland, Yuba County. A stiffish, glaringly orange-red loam, forming the soil of the undulating uplands stretching from the foothills several miles into the valley, and but little above the general level of the latter; tills easily when taken in the right moisture condition, but plows very cloddy when either too wet or too dry; is chiefly given to pasture and wheat growing, and yields fifteen to twenty, and sometimes twenty-five bushels of fall or winter-sown grain in good years—in poor ones eleven to thirteen per acre, but never altogether fails; responds very kindly to summer fallowing; in its natural condition has almost only herbaceous vegetation, with some scattered poison oak bushes.

No. 51. *Red surface soil*, from the foothills near Auburn, Placer County; taken twelve inches deep. Sent by Mr. N. S. Prosser, of Auburn. Original vegetation, oak (*Q. Douglasii*), pine, and chaparral. This is a fair sample of the red soil of the placer mines, which seems to contain a small amount of gold everywhere, and has been washed on the small scale ever since the first discovery of gold in California. It is of a dark orange color, rather light in tillage and pulverulent when dry, forming a very fine reddish dust, of considerable repute. It contains throughout numerous fragments of slate, more or less decomposed, of all sizes, and is usually underlaid by the same, or its debris, at a variable depth, rarely less than several feet, unless lying on steep slopes.

No. 190. *Red loam soil*, from the foothill slopes, near Lagrange, Tuolumne County. Vegetation, scattered oak timber (mainly "blue" and white oaks), with little or no underbrush save some poison oak; also grass and flowers. A moderately heavy, glaringly orange-red loam, tilling well unless when very wet; but little gravel; not much in cultivation, save in gardens in this neighborhood; makes fine vegetables and fruits. Sample taken to twelve inches deep.

No. 191. *Red foothills soil*, taken two miles north of Merced Falls, on the Lagrange road, Merced County; depth, ten inches; a rather heavy clay soil, considerably mixed with gravel, brownish red; natural vegetation, grass, and scattered "blue" oaks; chiefly pastured at present, but capable of producing fifteen to twenty bushels of wheat per acre, in good seasons, and with good tillage.

No. 196. *Red gravelly soil*, from the rolling "hog-wallow" country about eleven miles north of Merced City, on Hopeton road, Merced County. This represents a rolling tract of foothill country extending southwestward from near Merced Falls toward, and gradually flattening out, terminating near the railroad between Atwater and Merced stations. The surface, even to the hilltops, is deeply scored into "hog-

wallow" mounds, separated by a maze of little channels filled with gravel, or sometimes cobblestones. In low, undrained places of this tract lies the "dry bog" soil, of which No. 701, from Tulare County—see above—may be taken as representing the best class. Land like No. 196 is not at all cultivated at present; but on the flanks of the ridgy tract lie lands like those at Huffman's—see No. 193, above—where grain culture is very successful. The country is treeless and free from underbrush.

SOILS OF THE FOOTHILL REGION.

	Shasta County.			Yuba County.	Placer County.	Tuolumne County.	Merced County.	
	No. 559. Red Soil, Redding Station.	No. 705. Red Chaparral Soil, Anderson.	No. 706. Red Chaparral Subsoil, Anderson.	No. 499. Red Loam Soil, Wheatland.	No. 51. Red Foothills Soil, Auburn.	No. 190. Red Soil, Foothills at Lagrange.	No. 191. Red Foothills Soil, Merced Falls.	No. 196. Hog-wallow, 11 miles north of Merced.
Insoluble matter	76.274 } 80.376	63.384 } 68.864	63.194 } 67.904	78.789 } 82.592	------ } 69.52	67.915 } 74.879	73.352 } 77.858	79.078 } 84.622
Soluble silica	4.102	5.480	4.710	3.803	------	6.964	4.506	5.544
Potash	.500	.417	.467	.249	.38	.352	.375	.208
Soda	.041	.052	.044	.035	.07	.126	.125	.111
Lime	.104	.288	.327	1.021	.96	1.544	.351	.394
Magnesia	.403	.207	.350	.471	1.09	.720	.840	.361
Br. oxide of manganese	.009	.037	.029	.018	.39	.031	.066	.033
Peroxide of iron	6.686	7.705	6.263	5.811	12.42	7.879	6.964	3.903
Alumina	8.480	14.443	17.434	6.283	10.97	9.864	8.804	6.660
Phosphoric acid	.036	.047	.064	.043	.16	.091	.067	.053
Sulphuric acid	.012	.074	.043	.019	.01	.362	.221	.082
Carbonic acid	------	------	------	------	------	------	------	------
Water and organic matter	3.968	7.680	7.229	3.644	5.14	3.766	5.060	4.143
Totals	100.615	99.815	100.154	100.186	101.11	99.614	100.742	100.570
Hygroscop. moisture, absorbed at 15 °C.	5.049	9.998	10.749	4.81	------	5.421	6.114	4.967
Humus	------	1.42	------	0.466	1.14	0.715	0.712	.758
Available inorganic	------	------	------	0.336	1.12	0.448	0.467	.533

The above analyses show that the soils of the foothills are more variable in their composition than would be inferred from the general similarity of their appearance, viz.: a high orange-red tint, arising from the presence of from about four to over twelve per cent. of finely diffused iron oxide (ferric hydrate), and a texture varying from that of moderately heavy loam to a stiff clay, with more or less of rolled gravel; at times to such extent as to impede tillage, and occasionally so closely packed as to render cultivation unprofitable. Their capacity for absorbing moisture is in all cases fair and adequate, in some cases high.

The supply of lime is hardly adequate for such heavy soils in the case of those from Shasta County; in that from Redding, lime is deficient, and should be supplied where thriftiness is desired, and the same would be advantageous in the Anderson soils. Farther south the lime percentage increases, being high in the region from Wheatland to the Tuolumne, near Lagrange, but again comparatively low in the foothills and hog-wallow ridges of Merced County. The superior adaptation of that middle region to fruit, and especially grape culture, is doubtless connected with this fact. The supply of potash is only moderate, in some cases low for such heavy soils, as in Nos. 499 and 196. In the case of the soil from Redding, the higher potash supply offsets, in a measure, the deficiency in lime. As to the supply of phosphates, it is on the average quite low, deficient especially in the Redding soil, and likewise, considering its heaviness, in the Anderson soil. In the latter case, the use of bone-meal, recommended by me to Mr. Geo. A. Moore, has resulted in a suprising improvement of production, thus proving the correctness of the indication furnished by analysis. The soil in its natural state failed altogether to produce remunerative crops, scarcely giving back the seed sown—"about one and a half tons of hay on six acres, and potatoes at the rate of about one tenth of the bulk planted," as stated by Mr. Moore. The use of lime would doubtless still farther help the thriftiness of this soil.

From the small amount of humus shown in the analysis of the Wheatland soil, it seems probable that the sample represents a subsoil rather than the arable soil itself, and it may be that in the latter the phosphates would show a higher percentage. In the sample analyzed the phosphates are deficient, but the productiveness would, for the time being, be maintained, in consequence of the presence of so much lime and the greater lightness of the soil. Before long, however, phosphate manures will be in order in that region.

The soil from Auburn is altogether the best of the foothill soils thus far examined, having a large supply of phosphoric acid, with plenty of lime, a fair supply of potash, and a high percentage of humus. The analysis shows good reason for the high estimate in which this region is held for the production of fruits, grapes, etc. The soil from the Lagrange foothills is not quite equal, but still a high grade soil. That from near Merced Falls, No. 191, ranks somewhat lower, being very gravelly, and having a smaller supply of both lime and phosphates; while the soil of the "hog-wallow" ridge, No. 196, ranks still lower, on account of deficiency in potash. To southward, in Fresno and Tulare Counties, lime is again on the increase, as is indicated by the character of the valley soils, and the occurrence of limestone in the foothills themselves; but no analyses of soils from these southern foothills have as yet been made.

It is thus evident that there are considerable differences and alternations in the character and value of the foothill lands, and that, while the greater portion is probably of fair to high quality, especially for fruit culture, there are tracts requiring manures from the very outset. Such can doubtless be recognized by an attentive observer, from their vegetation. But my own observations, as well as the reports thus far received, are not sufficiently extended to determine what are the characteristic plants of each.

In view of the great uniformity of these soils to a depth of fifteen or more inches, and their usually somewhat stiff character, deep and thorough tillage is indicated as of especial importance in their cultivation.

Soils of the foothill valleys. As even the apparently uniform red soil of the foothills varies not inconsiderably, the same must be true to even a greater extent as regards the individual valleys within the region, traversing belts of widely varying rocks. While it is true that the rivers of the Sierras most frequently emerge from the hilly country through narrow gorges or cañons, yet not inconsiderable areas of valley lands exist among the foothills. The following analyses were made originally with a view to a comparison between the original soil of a valley, and the slum, or "slickens," that has overrun the same; but they are equally interesting, as showing the wide divergence of the soil of individual valleys from the general average, whether of the foothills or the Great Valley itself.

No. 67. Mining slum soil, sent by Mr. J. Taylor, of Mount Pleasant, near Chinese Camp, Tuolumne County, December 16, 1877. The soil is a fine, cinnamon-colored sediment, deposited from the washings of the hydraulic gold mines of Chinese Camp and Montezuma. Some of the lumps in the soil were very hard to pulverize, yet most of them yielded to pressure between the fingers.

No. 68. Valley adobe soil, sent by Mr. J. Taylor, of Mount Pleasant, December, 1877. It is a black, clayey soil, now underlying the "mining slum" soil (No. 67), at a depth of two feet, and was quite fertile.

Soils of Foothill Valleys, Tuolumne County.

	No. 67. Mining Slum Soil.	No. 68. Valley Adobe Soil.
Insoluble residue	72.98	56.61
Potash	.19	.19
Soda	.21	.14
Lime	1.19	.68
Magnesia	2.32	13.74
Br. ox. manganese	.08	.08
Ferric oxide	9.30	18.43
Alumina	10.55	
Phosphoric acid	.08	.07
Sulphuric acid	.03	.01
Organic matter and water	4.43	9.84
	101.36	99.79
Humus	.42	1.614
Available inorganic	.36	.395

The slum material is quite poor in the two most important ingredients of plant food, potash and phosphoric acid, and it will probably be somewhat refractory in tillage for some time. In humus and

available plant food, it is naturally poor as yet, but its redeeming feature, the large percentage of lime, will enable it to overcome this objection after having been covered with vegetable growth for some time.

No. 68 is a very remarkable soil, in more than one point of view. On the whole it is not dissimilar to the "slum" soil that has overrun it, and as regards the essential ingredients of plant food it is no richer than the latter, except as regards the humus, and, consequently, the nitrogen and proportion of available plant food. For the time being it would produce better than the slum soil, but ultimately both would be about equally durable, while neither takes a high rank in that respect. The unique feature of the adobe, in this case, is the extraordinary amount of magnesia, in which it exceeds all cultivatable soils that have come under my notice heretofore. Both soils are doubtless derived substantially from the same original source, but the magnesian rock-powder has, in the case of the adobe, been so far decomposed by atmospheric action as to render its base soluble in the acid used in the analysis, while in the slum soil most of the magnesia has doubtless remained in the insoluble part.

A comparison of this "slickens" sediment with those previously discussed (No. 10) shows that there must be a very great difference in the agricultural value of the sediments coming from different valleys; for if the general sediment of the Sacramento River is so rich, despite the incoming of such materials as the one last described, the slum coming from some of the valleys must be of extraordinary richness and a benefit to any lands covered by it, to any moderate extent, when unaccompanied by the floods of gravel that render the richest materials practically useless for the purpose of the husbandman.

The sediment No. 67 now covers the original soil, No. 68, to a depth at which the latter is practically out of reach of the roots of crops.

4. SOILS OF THE SOUTHERN REGION—LOS ANGELES, SAN BERNARDINO, SAN DIEGO, MOJAVE DESERT.

Ascending the mountains from Kern Valley, near Bakersfield, through the Tehachipi Pass, we emerge upon the Mojave desert, a plain-like basin surrounded by mountains, and more or less traversed by rocky ridges. In crossing it by rail during the dry season, the traveler is generally impressed with the idea of hopeless aridity, which is scarcely relieved by the only tree growth visible from time to time, viz.: the yucca (here commonly but erroneously named "cactus"), whose awkward branches, terminated by tufts of rigid, lance shaped leaves, impart rather a weird aspect to the landscape, and seem as uninviting to the agricultural prospector as the clouds of dust and sand that whirl about the train. But while it is true that there are some portions of this region whose deep sand beds seem to consign it to the true "desert land" class, there are other and very extensive tracts, having a soil of considerable native fertility, whose powers only need the life-giving agency of water to transform the desert into luxuriant fields and gardens. That this is so has repeatedly been shown by actual experiment at points where water was available. This is not at present the case at the railroad

station of Mojave; but the analysis of the soil from that neighborhood, given below, shows clearly that it is not inferior in productive capacity to some of the best soils of the great valley, which it greatly resembles, save in the scarcity of humus or vegetable matter. Its supply of lime and potash is high; that of phosphoric acid, low, but not more so than in some very productive soils of the valley. The scarcity of humus is the defect which it would be most needful to remedy; probably best by turning in a crop of alfalfa, which there could be no difficulty in growing where irrigation is available. There are doubtless many tracts where even this defect does not exist, since they are covered with a dense growth of small shrubs, under which grasses flourish in good seasons, giving pasture to sheep. Irrigation is here the all-important question, since the natural rainfall of about four inches, sometimes reduced to one or two, cannot be relied upon for any purpose. Only a detailed survey, however, can determine the tracts having an arable soil, as against those overrun by arid sand.

Descending from the Mojave basin to the southward, across the San Fernando and Sierra Madre ranges, we reach the Southern Region proper, characterized mostly by soils containing a large amount of gravel and coarse sand, and of a brownish or reddish tint. They are commonly distinguished into lands of the first bench, or bottom lands of the streams; lands of the second bench, forming either at the present time or originally a system of terraces elevated from fifteen to twenty-five feet above the bottom lands, and still readily irrigable from the headwaters of the streams. Finally, the mesa lands, lying at higher elevations, and with no definite relation to the present drainage system; and not, ordinarily, conveniently irrigable from the streams, but dependent upon sources of supply lying high up in the cañons. Of course, these distinctions are not absolutely maintainable; the second benches and lower mesa lands passing into each other imperceptably, especially on the upper portions of the streams, while again, in the lower portions of the same, the second bench lands often lie high enough to be classed as mesas. On the slopes of the mesa lands, the soil of the latter and that of the bench lands are of course frequently commingled.

While the first bench or bottom lands were the first cultivated, and rendered highly productive by irrigation, the second bench lands seem to be scarcely inferior to the former for fruit production, at least, when properly irrigated. No. 130 was selected as a representative soil of this kind. Its potash percentage is rather low, but it has a good supply of phosphoric acid and lime, and its easy tillage and great depth offsetting its somewhat low retentiveness of moisture, render it a very desirable soil. It is to be regretted that no analyses of the mesa soil from the Los Angeles region are as yet available for comparison.

The *mesa soil* from San Diego is of excellent composition in all respects but that of being somewhat deficient in humus, a fault easily remedied in cultivation. It is richer in both potash and phosphoric acid than the Los Angeles soil, but its smaller proportion of lime detracts somewhat from its advantage over the other. Considering its great depth and large supply of plant food, it is certainly of high promise, and would amply repay any reasonable expense incurred in its irrigation. Where convenient, this soil, especially where it is of the heavier kind, would be benefited by a moderate application of lime or marl.

The soil of the Colorado River bottom is certainly a highly productive one—easily worked, and not liable to suffer from wet in case of overflows—being quite light, notwithstanding its large percentage of alumina, as shown by analysis. It is a highly calcareous soil, containing as it does, over sixteen per cent of carbonate of lime, partly in concretions, but mostly in a finely pulverulent form. Its potash percentage is very high, yet there seems to be no trouble from alkali, as the soda percentage is quite small. Its supply of phosphoric acid is fair, though not large for a bottom soil; the humus percentage is likewise small for a lowland soil, yet adequate. It is therefore likely that whenever the water of the Colorado River shall be made available for irrigation, these bottom lands will yield rich returns for cultivation.

No. 332. Surface soil of the Mojave Desert, taken near Mojave Station, Kern County, by N. J. Willson, of the Central Pacific Railroad, to the depth of twelve inches. A moderately heavy, dun-colored loam, with little coarse sand, containing siliceous and other rock fragments; slightly effervescent with acids; somewhat "sticky" when wet, its color little changed. Would evidently till quite readily, but no cultivation has been attempted thus far. Vegetation, sagebrush, creosote plant, little grass.

No. 130. Surface soil of the second bench of the San Gabriel Valley, Los Angeles County; taken from Alhambra Ranch, near San Gabriel, December, 1877, by Mr. J. De Barth Shorb. "A fair sample of the heavier class of soils in the San Gabriel Valley." Color, dun or brownish-gray; showing at once a good deal of small gravel and coarse sand. This soil lies higher than that on which the older orange orchards of the valley are planted, but the tree seems to thrive equally well on it when given sufficient moisture.

No. 47. Surface soil of mesa land, such as forms the larger part of the arable land in the southern part of San Diego County. Taken by Mr. F. A. Kimball, of National Ranch, San Diego County, who thus describes it:

> The change of tint from surface soil to subsoil, occurs at depths varying from eleven to twenty-five inches, and the sample sent represents the average from widely separate places, but with the same kind of soil.
>
> The underlying subsoil varies in thickness from two to ten feet or more, and is very retentive, of a clayey nature.
>
> The orange, lemon, and olive seem better adapted to this "red mesa" soil that to the best valley soils of the San Diego, Sweetwater, Otay, or Tia Juana Rivers; a larger growth and earlier fruiting being invariable on the mesa. All the northern fruits, except perhaps the cherry and plum, are produced on it in the greatest perfection—the flavor of the apple and peach exceeding any I have tasted in Northern California or in the East.

The soil is of a light reddish-brown tint, rather coherent and apparently somewhat heavier in working than the soil No. 130, which it otherwise greatly resembles; containing, likewise, a considerable amount of visible gravel.

No. 506. Bottom soil from the Colorado River, between El Rio and Yuma Stations, San Diego County. A silty, pulverulent soil, of a light buff tint, dry lumps but little coherent, changes color but little in wetting, but becomes slightly plastic, showing some clay to be present. Unchanged to the depth of several feet; samples taken to twelve inches depth. Bears a heavy growth of mezquit trees, in low places arrowweed, on the Arizona side a great deal of creosote plant. Cultivation has not as yet been attempted here, but has been very successful lower down.

Soils of the Southern Region.

	Kern County.	Los Angeles Co.	San Diego County.	
	No. 332. Soil, Mojave Station.	No. 130. Soil of San Gabriel Valley.	No. 47. Soil of mesa land.	No. 506. Bottom soil, Colorado River.
Insoluble matter	70.965 } 75.964	81.12	86.21	58.574 } 63.901
Soluble silica	4.999 }			5.327 }
Potash	.928	.27	.48	1.177
Soda	.078	.17	.14	0.162
Lime	1.787	.68	.36	8.671
Magnesia	1.782	1.77	.54	2.966
Br. oxide of manganese	.026	.10	.10	.025
Peroxide of iron	5.478	6.30	3.69	4.139
Alumina	9.227	6.79	5.12	8.379
Phosphoric acid	.056	.16	.23	.133
Sulphuric acid	.012	.07	.03	.145
Carbonic acid	.456	------	------	7.818
Water and organic matter	3.903	3.07	2.60	3.344
Totals	99.697	100.50	99.50	100.860
Hygroscop. moisture ' absorbed at 15° C	10.759	2.30	2.34	9.264
Humus	.283	------	0.555	0.752
Available inorganic	.370	------	1.439	1.151

5. SOILS OF THE COAST RANGE SOUTH OF SAN PABLO BAY.

The characteristic reddish gravelly soils of the southern region extend to the seashore near Santa Monica, and southward wherever there is a bluff bank; while, where the surface descends more gently, as in the Westminster and Anaheim region, there are coast flats several miles in width, where the soil is a dark colored sandy loam, glistening with scales of mica, and more or less affected with alkali in the lower portions. Similar soils are found in tracts of greater or less extent, up the coast as far as Santa Barbara at least. None of these soils have as yet been analyzed, except with respect to the alkali salts sometimes present in them, which are at times purely saline, at others strongly alkaline from the presence of carbonate of soda, when the use of gypsum affords prompt relief. (See report of the department for 1877, pages 45 to 49.) As a rule, these seashore lands are very productive.

The valleys of the seaward slope of the Coast Range have mostly gray, light, and silty, rather than sandy soils, quite similar in appearance from Ventura to Humboldt County, though differing considerably in composition, those of the southern region being more calcareous, and apparently richer in phosphoric acid. Among the best agricultural valleys in this division is that of the Santa Clara River, in Ventura County, which opens out into the fertile plain of Saticoy. No soil samples from the latter have been received, but the following samples represent fairly the soil of the valley near Santa Paula:

**No. 168. Valley soil,* taken from Mr. N. B. Blanchard's orange orchard, near Santa Paula, Ventura County. A light umber, when wet blackish; silty soil, very easily tilled, and retaining its tilth remarkably, so that the hand can easily work its way to the elbow,

and an axe handle can be thrust down to the head with little exertion. The material remains apparently the same for from twelve to twenty feet in the lower bench of the valley where this sample was taken. Toward the hills there is a second bench, where the soil is apparently the same, but of a slightly reddish tint. On the mountain slopes the soil, still quite similar in its working qualities, is of decidedly reddish tint, and is remarkable for its retention of natural moisture, enabling it to produce corn without irrigation. A specimen of this soil is—

No. 182. Reddish mountain soil, from Mr. N. B. Blanchard's land, near Santa Paula; taken to twelve inches depth:

	Ventura County.				Santa Barbara County.	
	No. 168. Silty Soil, Lower Bench, Santa Paula.		No. 182. Mountain Soil (Reddish), Santa Paula.		No. 170. Hillside Subsoil ("Poison Soil") Hollister's Ranch.	
Insoluble matter	85.664	87.511	74.930	82.842	83.065	87.743
Soluble silica	1.847		7.912		4.678	
Potash		.634		.621		.506
Soda		.070		.164		.058
Lime		.759		.952		.561
Magnesia		.593		.955		.666
Br. oxide of manganese		.025		.036		.055
Peroxide of iron		3.350		5.070		3.116
Alumina		3.095		5.939		2.995
Phosphoric acid		.200		.127		.223
Sulphuric acid		.003		.039		.094
Carbonic acid		----		----		----
Water and organic matter		3.132		2.669		3.854
Totals		99.372		99,414		99.871
Hygroscop. moisture, absorbed at 15° C.		5.488		6.590		5.980
Humus		.841		1.055		1.341
Available inorganic		.368		1.004		.271

Both soils show an excellent composition, the valley soil having the advantage of a high percentage of phosphates, while the mountain soil, a little heavier, with a smaller amount of phosphates, has a higher lime percentage, and more humus. These soils are especially interesting as being peculiarly favored in regard to their relations to moisture, as has been stated in detail in the last report, pp. 19, 20, and 34. No. 168 remains moist within fifteen to twenty inches of the surface during the driest part of the season, when the water table falls as low as twenty feet. The same is true more or less of the Saticoy plain at large; and the soil of other valleys, as, *e. g.*, the Ojai, is measurably similar. So are, probably, the valley soils of Santa Barbara, so far as I have the opportunity of examination. The only one thus far analyzed is the following:

No. 170. Subsoil of second bench land on Col. W. Hollister's ranch, near Santa Barbara (see table above). This specimen was taken and examined not as a fair sample of the land, but with a view to detecting the cause of the dying-out of orchard trees some years after coming into bearing, that occurs in streaks both here and elsewhere in the Santa Barbara region. The surface soil is dark gray or blackish, several feet in depth at most points, but where the dying out occurs is underlaid

by a whitish, sandy hardpan with pale rusty spots, indicating imperviousness and bad drainage. The spots are, however, known as having "poison soil," the trouble being ascribed to some injurious substance contained in it. The analysis shows no cause for any injury in the chemical composition of this subsoil, which is very fair in every respect, showing a high percentage of phosphoric acid, potash, and lime, and even, somewhat unexpectedly, of active humus. The cause of the difficulty is doubtless a mechanical one, the tree roots after a certain time reaching an impervious layer, waterlogging their roots in Winter and leaving them unable to seek moisture in the depths of the soil in Summer. Deep subsoiling, breaking up the hardpan layer, seems to be the only possible remedy.

The following two are soils from the Salinas Valley region:

No. 606. Upland soil from Poverty Hill, San Benito County. Collected by Mr. H. Partsch, for the United States census; taken to the depth of twelve inches. Soil of a dun color, somewhat silty, dry lumps easily crushed by fingers; soften readily in water, the color darkening but little; easily tilled and apparently not adhesive; produces moderate crops in good seasons, but is unthrifty and risky. This kind of land lies in the depressions of a kind of bench across the eastern head of the Santa Clara Valley, while the higher portions are formed of a gray adobe, which also forms the subsoil of the loam lands, at varying depths.

No. 600. Loam upland soil from Soquel Ranch, Santa Cruz County. Collected by Mr. Herman Partsch. A reddish umber colored loam when dry, the lumps crushing easily between the fingers; blackish tint; lumps softening quickly on wetting; very easily tilled; containing some coarse sand. This sample represents the soils of the upland terrace which abuts upon the seashore southward of Santa Cruz.

	San Benito County.		Santa Cruz County.	
	No. 600. Upland Soil, "Poverty Hill."		No. 606. Loam, Upland Soil, Soquel.	
Insoluble matter	85.596	88.163	80.426	83.454
Soluble silica	2.567		3.028	
Potash		.333		.343
Soda		.109		.126
Lime		.676		.502
Magnesia		.526		.390
Br. oxide of manganese		.048		.014
Peroxide of iron		2.856		3.928
Alumina		4.214		5.711
Phosphoric acid		.027		.053
Sulphuric acid		.015		.009
Carbonic acid				
Water and organic matter		3.476		4.955
Totals		100.453		99.485
Hygroscop. moisture absorbed at 12.5° to 15°C.		5.218		5.602
Humus		.819		1.463
Available inorganic		.284		.579

These soils, while still of the same general physical character as those of Ventura and Santa Barbara, differ chemically by their

smaller percentage of potash and phosphoric acid; the latter being very decidedly deficient in the "Poverty Hill" soil. Their lime supply is still, however, quite adequate for thriftiness in such light soils, which, like those farther south, show a very satisfactory and remarkable uniform power for absorbing moisture, viz.: from about five and a half to six and a half per cent. It is evident that here, as in the San Joaquin Valley, the phosphates will be the first thing requiring replacement when these soils become "tired," and fruit rather than grain culture should be pursued by those cultivating them. It is not, of course, certain that these soils represent the character of the Salinas region correctly.

The following analysis of a valley soil, from near Pescadero, San Mateo County, shows it to be of a somewhat higher grade than the above, and approaching more nearly, in character, the soils of Ventura, above described:

No. 37. Valley soil, from a small valley between Pescadero and Benton Creek, about two hundred feet above sea level, and two and a half miles away from the shore, sent by Pescadero Grange. Selected by Messrs. Osgood, Burch, Weeks, and Thompson, Committee. A brownish black loam, somewhat hard, when dry, but softening easily on wetting, and taking almost a black tint; produces good potatoes, barley, and oats. The product of the first named crop has fallen, by cultivation, from 28,000 to 12,500 pounds—the cereals not so much. Deep tillage and thorough pulverization is found to be very beneficial in dry years. The timber in the valleys is redwood, oak, and alder, with buckeye—madrone and pine on the uplands:

Insoluble matter	78.084	81.321
Soluble silica	3.237	
Potash		.541
Soda		.231
Lime		.925
Magnesia		.820
Br. oxide of manganese		.039
Peroxide of iron		4.934
Alumina		4.821
Phosphoric acid		.084
Sulphuric acid		.027
Carbonic acid		------
Water and organic matter		6.757
Total		100.500
Hygr. moisture, 15°C.		7.387
Humus		2.850
Available inorganic		.625

This soil shows a high lime percentage, a large one of potash, and a considerably higher amount of phosphoric acid than the Santa Cruz soils, though yet rather low, being only half of that contained in the valley soils of Ventura and Santa Barbara. While sufficient for present thriftiness, in presence of so much lime, it is pretty certain to need phosphates so soon as its first fertility is exhausted, especially where dairying is the chief industry. The humus percentage is remarkably high for so light a soil within the coast region. It probably represents fairly the favorite soil of the redwood.

While on the seaward slope of the Santa Cruz range there is an evident predominance of light loam soils, the landward portion of that range seems to possess large tracts of heavy red clay soils, whose character, of course, influences more or less that of the valley soils derived therefrom, especially in Santa Clara County. On the mountain slopes these lands are largely covered with "chaparral" (*Ceanothus*) and other scrub growth. The following is the analysis of a sample sent by Mr. William Pfeifer, from a tract lying two miles northeast of Saratoga:

No. 702. Chaparral soil. Saratoga, Santa Clara County. Dark reddish-brown when dry, forming hard lumps; dark umber color when wet, and softening easily; quite stiff in working, but assuming good tilth when taken at the right stage of moisture. Sample taken to the depth of twelve inches, below which lies a gravelly rather stiff clay subsoil of an orange tint; more or less angular fragments of the country rock (a fine, soft, calcareous sandstone or shale) are contained in both.

SANTA CLARA COUNTY.

		No. 702. Chaparral Soil, Saratoga.
Insoluble matter	57.449	62.563
Soluble silica	5.114	
Potash		.859
Soda		.260
Lime		1.987
Magnesia		2.428
Br. oxide of manganese		.098
Peroxide of iron		10.019
Alumina		9.516
Phosphoric acid		.139
Sulphuric acid		.063
Carbonic acid		----------
Water and organic matter		11.921
Total		99.853
Hygroscop. moisture absorbed at 15 °C.		12.090
Humus		3.096
Available inorganic		.884

This analysis gives high testimony to the intrinsic value of this soil. It has an abundant supply of potash as well as of lime, even for such a heavy soil. Its phosphoric acid percentage is fair; its supply of humus somewhat extraordinary for a soil formed in an "arid" climate. Its power for absorbing moisture is very high, from the concurrence of the large humus supply with that of iron oxide (ferric hydrate). It is, therefore, a soil of great resources, and well deserving of the high culture which its peculiar mechanical condition necessitates. It must be kept thoroughly and deeply tilled, and its somewhat refractory subsoil should be broken up so as to allow roots deep penetration. Not being irrigable, on account of its location, its best adaptation would seem to be to the growing of sweet grapes, for the table, for raisins, or heavy wines. A very similar soil is found in some of the vineyards near Mission San José, and under high cultivation, has yielded excellent results.

The Mt. Diablo range, from San Pablo and Suisun Bays to San José, has mostly heavy "adobe" soils on its flanks and in the smaller valleys, as well as on its eastern foot, in the San Joaquin Valley; and the heavy grain crops produced, even to the very summits of the ridges in good seasons, testify to the fertility of these somewhat refractory soils, whose productiveness varies sensibly in accordance with the amount of lime present in them; and this, again, can in a measure be judged of by the more or less dark tint of the soil. Limited deposits of impure limestone occur with frequency among the clayey and siliceous shales of the range, in which calcite or carbonate of lime commonly fills the rock crevices. Where this is not the case, we occasionally have tracts of heavy clay soils of tawny tint, cold and refractory, and often ill-drained, with the siliceous, shaly bed-rock, a few feet beneath the surface. Such, unfortunately, happens to be the character of a large part of the University experimental grounds; while in the valleys lies an excellent black adobe soil, derived from the higher portions of the range. The following analyses show the composition of these soils:

Nos. 1 and 2. Black adobe soil and subsoil, taken on the State University campus, Alameda County; in the rear of Cottages 3 and 4, half way to the bridge.

The black soil here is over thirty inches deep, underlaid by a yellow, stony, subsoil. It becomes exceedingly "sticky" when wet, but plows easily when taken just at the right point of moisture; when plowed a little too wet, clots heavily, but the clods tend to pulverize in drying. With shallow tillage, or when left untilled, it forms widely gaping cracks in the dry season. If tilled deeply and thoroughly, it retains moisture and a luxuriant growth of weeds throughout the dry season, and is almost ashy in its tilth.

The soil having been sown in grain, so far as known, for many years, and worn badly, it was deemed best not to take the surface soil for analysis, but a layer from twelve to twenty-two inches depth, and then another from twenty-two to thirty inches; the latter representing the extreme probable range of crop roots. The results of the analyses of both of these layers are given in the following tables:

No. 4. Ridge adobe subsoil, taken from the crest of the ridge on the agricultural grounds of the University, in the orchard; from the depth of ten to that of twenty inches. Tint, a tawny yellow; very heavy in working, difficult to till at all times, and remaining wet until late in Spring. At a depth varying from two and a half to five feet, it gradually passes into "rotten" shaly clay-sandstone, fragments of which are everywhere intermixed with soil. The tract is ill-drained even on the ridge; it is esteemed a poor soil.

SOILS OF AGRICULTURAL GROUNDS, BERKELEY.

	Black Adobe.		Ridge Adobe.
	No. 1. Soil. 12–22 inches.	No. 2. Subsoil. 22–30 inches.	No. 4. Subsoil. 10–20 inches.
Insoluble residue	77.844	69.563	86.002
Potash	.452	.348	.189
Soda	.074	.109	.154
Lime	1.050	.998	.484
Magnesia	1.211	1.913	.452
Br. ox. manganese	.078	.093	.038
Ferric oxide	4.675	7.208	4.013
Alumina	7.788	13.970	5.532
Phosphoric acid	.231	.116	.057
Sulphuric acid	.077	.028	.021
Organic matter and water	5.718	6.600	4.051
	99.198	100.946	100.993
Hygroscop. Moisture, at 15° C.	7.36		
Humus	1.75		

The obvious similarity of the California adobe to the "black prairie" of Mississippi and Alabama, is abundantly confirmed by these analyses. Both in mechanical and chemical composition, the adobe is so nearly like the "white lime prairie" soil of Mississippi that the differences are scarcely greater than might be found in different localities in either region. The prominent features are the high percentage of clay, as well as of the finest sediments, the influence of which in rendering the soil heavy in working is offset by a large supply of lime and black humus. The supply of potash is fair; that of phosphoric acid large, being one third above that of the Mississippi prairie soils. This explains the fact that grain crops, so exhaustive of that ingredient, have for a succession of years been grown on the California soil without apparent diminution. The subsoil below twenty-two inches seems to decrease gradually in the supply of plant food. The sample analyzed probably represents pretty correctly the black adobe soils of the Coast Range slope from San Pablo to Mission San José.

The differences in the mechanical * and chemical composition of this ridge adobe from that of the valley is sufficiently striking. It contains less than two thirds the amount of clay, yet it is much heavier in working, owing to the small quantities of the finer sediments, which chiefly serve to break up the extreme tenacity of pure clay, that is but little disturbed by the large sized grains. Then the soil contains less than half as much lime as the lowland adobe; less than half, also, of the primarily important ingredients, potash and phosphoric acid; and, finally, a mere trace of vegetable matter, or humus, as is shown both by its tint and by the smallness of the "organic matter and water" item.

The unproductiveness of this soil is clearly owing to two causes combined: it is naturally poor in plant food; and its mechanical composition makes it so refractory that it is only in exceptionally favorable seasons that what it does contain of plant food can remain

* See table of mechanical analyses, below.

available to plants, since, in drying, it becomes of stony hardness, with only cracks to aid the circulation and penetration of air and roots.

This is one of the cases in which improvement by merely supplying the plant food, would be a waste of money, unless the physical condition be corrected at the same time. Underdrainage would probably do this most effectually; green manuring would also be a very important aid. But the unusually small amount of clay for so heavy a soil, promises excellent results from the use of a moderate quantity of quicklime, or marl; and the fertilizer experiments since made on the University grounds have fully sustained this inference, as shown in the last report, page 54.

Locally, we often find the heavier soils of the Coast Range so modified by the admixture of gravel and sand derived from irregularly distributed geological deposits of this character, as to render them easily tilled and specially adapted to the culture of barley and fruit. This is more or less the case along the streams on the borders of San Francisco Bay, but especially so in Livermore Valley, that remarkable basin inclosed between two branches of the Coast Range, with apparently an ancient outlet through the San Ramon Valley towards Suisun Bay. Near Pleasanton, the hills are flanked and even capped by gravel conglomerates, which here, as well as farther up the "Arroyo del Valle," have largely contributed toward the formation of the valley soils, which are of remarkable depth and of course of easy tillage. I regret that of a collection of the soils of the region made by myself, only one sample has afterwards come into my possession, and this is local rather than representative, yet it shows in a measure the general character of the valley soils.

No. 649. Sediment soil from the "Ojo del Monte," a small valley just above the final exit of the "Arroyo del Valle" from the mountains, at the southeastern end of Livermore Valley, Alameda County. Whitish, silty soil, with some tangible sand intermixed; easy of tillage, and of very uniform character to the depth of several feet. Covered with a dense shrubby and herbaceous growth, and some sycamore trees.

VALLEY SOIL, OJO DEL MONTE, LIVERMORE VALLEY.

	Alameda County. No. 649.	
Insoluble matter	71.156	76.094
Soluble silica	4.938	
Potash		1.143
Soda		.123
Lime		2.049
Magnesia		3.046
Br. oxide of manganese		.044
Peroxide of iron		5.648
Alumina		7.153
Phosphoric acid		.117
Sulphuric acid		.101
Carbonic acid		1.004
Water and organic matter		3.679
Total		100.201
Hygroscop. moisture, absorbed at 15 °C		5.668
Humus		0.396
Available inorganic		0.413

The analysis shows this soil to be a highly calcareous one, with an exceptionally large percentage of potash, and moderate, but under the circumstances adequate supply of phosphates; a good moisture, coefficient, but a very small supply of humus. These characters may, of course, be expected to be found more or less modified in the alluvial soils of the lower valley, which have received the admixture of the adobe and gravel of the Coast Range hills, and of the reddish clay soils that characterize the hilly lands lying just west of Livermore. While unable to say anything definite in regard to these, I feel well assured that so far as the soil is concerned, the culture of the grape, now so extensively inaugurated in that region, may be expected to be eminently successful in the valley lands, particularly in the deep gravelly soils near and to southward of Pleasanton.

6. SOILS OF THE COAST REGION NORTH OF SAN PABLO BAY.

But few specimens of soils from the coast region lying northward of San Pablo Bay have thus far been received, and hasty personal visits have given me only a very general idea of their character and distribution. Unlike the Mt. Diablo range, the mountains of Napa and Sonoma are largely formed by rocks of eruptive or volcanic origin; and where these prevail the soils are naturally different from those of the cretaceous and tertiary region south of the Bay. To the volcanic origin of their soils, the high quality of the wines of the two counties just named has largely been ascribed. Much of the rock constituting the lower and more level portions of the ranges of Sonoma and Napa is a soft, mostly whitish or white tufa, into which cellars have been readily excavated, and which gives rise to a more or less heavy clay soil—white adobe in the valleys, a red and more or less gravelly soil on the ridges. These tufa plateaus alternate with belts and ridges—mostly the higher points—composed of darker tinted, harder, and crystalline or scoriaceous rocks, less easily decomposed than the tufa, and giving rise to soils of a lighter character, deeply tinged with iron when on the slopes, but also becoming gray or whitish in the valleys, from the removal of the iron by leaching. Of course there are all kinds of transitions between these two extremes, and occasionally even a genuine black adobe will locally show the prevalence of the calcareous sedimentary rocks.

The two samples, of which the analyses are given below, represent respectively the lighter sediment soils of the Sonoma Valley lying near the foot of the slope, and the red soil of the mountain sides themselves.

No. 185. Valley soil, from the lower portion of the vineyard of G. F. Hooper, lying within a hundred yards of Sonoma Creek, Sonoma County; taken to the depth of twelve inches. A medium light loam soil, of a reddish-buff tint when dry, blackish when wet; dry lumps crush readily between the fingers, soften quickly when wetted, and show some plasticity, so that the soil cannot be worked when very wet. Has grown excellent Zinfandel grapes for a number of years; originally timbered with oaks and grapevines.

No. 188. Red mountain soil, from the higher portion of G. F. Hooper's land, now occupied by orange and chestnut trees; taken to twelve inches depth, and similar in appearance for two or three feet; a brownish red loamy soil, containing rock fragments intermingled; the color darkens somewhat in wetting; the dry lumps can be crushed

by the fingers, but soften slowly on wetting, and become only moderately plastic. The soil is quite light in tillage, and produces well; is evidently especially adapted to fruit culture, favoring early fruiting as well as early maturity. The original growth is oaks, manzanita, and some "chaparral."

	Sonoma County.	
	No. 185. Valley Soil, Hooper's Vineyard, Sonoma Valley.	No. 188. Red Mountain Soil, Hooper's land.
Insoluble matter	76.089 } 82.928	34.392 } 48.502
Soluble silica	6.839 }	14.110 }
Potash	.435	.319
Soda	.123	.058
Lime	.744	.670
Magnesia	.578	.712
Br. oxide of manganese	.025	.146
Peroxide of iron	5.793	25.955
Alumina	5.092	12.160
Phosphoric acid	.187	.166
Sulphuric acid	.171	.274
Carbonic acid	-----------------	-----------------
Water and organic matter	3.715	11.640
Total	99.791	100.436
Hygroscop. moisture, absorbed at 15 °C.	4.980	13.710
Humus	1.111	2.537
Available inorganic	.371	1.171

While differing widely in their aspect and physical properties, and in some points of their chemical composition, these two soils are yet not very far apart in the most essential point—the supply of plant food. In its percentages of potash, phosphoric acid, and lime, the mountain soil stands somewhat below the valley soil, yet the supply of all three is fair. In humus the mountain soil exceeds that of the valley nearly one and a half times, and this, together with its extraordinary iron percentage, accounts for its very high power for absorbing moisture, that forms a very effective safeguard against injury from drought. On the whole, the advantages of the two soils are very evenly balanced, its location giving the valley soil a similar degree of security against drought; but it is evidently more liable to injury from frosts and wet than the hill soil. The latter, with its eastern exposure, seems certainly preëminently adapted to grape culture; and this adaptation is confirmed by the excellent results obtained in the vineyards of Köhler & Froehling, located on a similar soil higher up the valley, as well as in the well known "Schrammsberg" Vineyard, northwest of St. Helena, in the Napa Valley. I think it probable that whenever quality shall be more evenly balanced against the mere quantity of production, the red mountain slopes of both valleys will be occupied by vineyards as high up as the vine will grow, and will produce the choicest wines of the region. In the Napa Valley especially, the vineyards are steadily advancing up the hillsides already, and on Howell plateau, at an elevation of 2,000 feet,

virgin soil, and equally for the difficulty in tillage complained ...
A few years' cultivation will still farther reduce the small amount of

..hen in any soil it falls materially below 4.0, that is, four per cent of the weight of the soil after exposure to fully moist or "saturated" air at the

ordinary temperature, experience shows the soil to be liable to injury from droughts of even short duration. Moisture-coefficients ranging from 4.0 to 8.0 are in general those most to be desired, as they belong to what is practically termed "warm" soils. When rising considerably above eight per cent, the indication is that the soil is inclined to be heavy in tillage, except in cases where the high absorption of moisture is due to the presence of a large amount of humus, or (in red soils), of iron (ferric hydrate.) The laws governing this matter in different cases are not, however, fully understood as yet. Investigations on this subject have been in progress here for some years past, and are being continued. A portion of the same, carried out by a student of the Agricultural College, as his graduating thesis, is appended, as forming an important contribution to the existing knowledge on the subject. A more general discussion of the whole subject would lead beyond the limits necessarily assigned to this report. A summary of the mechanical soil analyses thus far made is given in Table II.

THE ABSORPTION OF MOISTURE BY SOILS UNDER VARYING CONDITIONS OF TEMPERATURE AND MOISTURE.

[By LEONARD FISHER, Ph. B., University of California, 1881.]

"The hygroscopic property of the soil is of the utmost agricultural importance, because, first, it is connected with the permanent moisture which is necessary to vegetable existence; and second, the absorption of water vapor to some degree determines the amount of absorption of other vapors and gases." *

The present investigation concerns water vapor only, as the absorption of such gases as carbonic acid, ammonia, etc., and the benefits thereby accruing, are treated of very fully in most agricultural text-books.

A knowledge of the hygroscopic power of soils under various degrees of humidity and temperature of the atmosphere, affords a partial measure of their capabilities in resisting drouth. Plants derive all their mineral food from the soil by absorbing it in solution through the roots, and it has been shown by Sachs that the process of nourishment continues in air-dry soils so long as the tap roots can reach and supply moisture, and the soil temperature is not excessively high. If through any series of experiments, tables could be constructed or general laws deduced by which we could ascertain in percentage statements the hygroscopic power of typical soils at a normal temperature, and also the changes in their absorptive power under varying meteorological conditions, we should be able to predict with much more certainty whether they would be likely to stand in need of irrigation.

From experiments made by E. Risler (Jahresbericht der Agrikultur Chemie, 1868), it appears that the minimum of water in the soil necessary for plant life is largely dependent on the humidity of the air. In a warm, dry atmosphere the evaporation from the leaves will be much greater than in cool, moist climates, and hence the supply of water in the soil must be proportionately larger in the former case in order to meet the increased demand. In arid climates, therefore, a knowledge of the hygroscopic power of the soil is doubly important.

The experiments made by Mayer, from which he concludes that the hygroscopic moisture of soils is unimportant to plant life, are radically defective and inconclusive in consequence of having been conducted under circumstances (in flower pots) altogether different from those existing in the case of crops growing in the open field, and having at their disposal a moisture supply in the subsoil; besides, they are contradicted by the well known experiments of Sachs, above referred to.

Soils having high moisture coefficients (and Prof. Hilgard has found some in which it is as high as 23 per cent) would require so much heat and so long a time to dry out and attain an excessive temperature, that capillary water in connection with the comparatively short time of exposure to the sun's heat, would maintain a sufficient supply for the undisturbed support of plant life. On the other hand, soils of very low moisture coefficient, being largely siliceous, and therefore easily warmed and retentive of heat, might readily lose their small amount of water during one of our Summer days, and become heated and dry to so great a depth that no plant could survive. Moreover, in consequence of its slight absorptive power, the dry heat would be maintained so far into the night that when the sun again rose the soil would be far from having reached its point of full saturation.

It is a general fact that the absorption or condensation of the vapor of water by solids is dependent on the nature of the substance and the amount of surface exposed. Applying this to soils, we should infer that the amount of hygroscopic moisture in any given soil depends: First,

* Johnson's "How Crops Feed."

on the character of the soil; second, on the amount of vapor present, it being greatest in the presence of a fully saturated atmosphere at a high temperature; and third, that the rapidity of absorption depends on the degree of tilth.

The following experiments were undertaken to determine how far the amount of absorption, of which any given soil is capable, depends upon both the humidity and the temperature of the surrounding air, Knop having stated that the absorption is determined solely by the temperature, without any regard to the amount of moisture present.

Three typical soils were chosen; one, the soil from Putah Valley, as representative of a widely prevalent class of alluvial loams, rich in humus; the second, a black adobe from the University grounds, as the type of heavy calcareous clay soils, also rich in humus; while the third, a light, calcareous silt soil, from Fresno, represents soils deficient, both in clay and humus. Unfortunately, only one of these soils has thus far been mechanically analyzed, but their chemical analyses are here given, as affording some clue to their nature.

	No. 110. Dark Alluvial Loam, Putah Valley, Solano County.	No. 1. Black Adobe Soil, University Grounds, Alameda County.	No. 704. Calcareous Silt Soil, Fresno County.
Insoluble residue	67.334	77.844	85.874
Soluble silica	3.671		2.705
Potash	.929	.452	.340
Soda	.124	.074	.248
Lime	.770	1.050	1.163
Magnesia	2.285	1.211	.499
Oxide of manganese	.106	.078	.034
Oxide of iron	8.011	4.675	3.277
Alumina	9.160	7.788	3.222
Phosphoric acid	.111	.231	.098
Sulphuric acid	.120	.077	.488
Organic matter and water	7.115	5.718	1.789
Total	99.736	99.198	99.737
Humus	1.709	2.33	.604

The apparatus and method used in the absorption experiments were those adopted by Professor Hilgard in his general work, viz.: A box or bell-glass lined inside with wetted blotting paper, insuring full saturation. For the higher temperatures this apparatus was inclosed in a large sheet iron heater. A thin layer of soil was sifted on a little shelf within the absorption vessel, and left exposed for a time not less than six hours, that time having been found by experiment to be adequate for full saturation. To obtain a half-saturated atmosphere a solution of chloride of calcium of sp. grav. 1.3418 (as determined by Gay Lussac) was used. The saturated soil was dried at 200° C, and weighed. The results are shown in the following table:

evaporation during the day of such a large amount of water would keep the soil cool, never permitting it to be dried deep enough to injure the roots of the growing crop, while during the night it would speedily regain its percentage of moisture by absorption from the atmosphere or the underlying soil. In the adobe soil, however, the limit of safety is much narrower, so that plants would be much sooner injured during the prevalence of dry northers; and in the silty soil, a concurrence of unfavorable circumstances would speedily result in the shriveling up of any feeding roots lying near the surface. It is thus obvious that in dry seasons, where the question of success or failure is delicately balanced, the difference in the factor here under consideration might readily turn the scale for or against the farmer's interest.

formation of soils in the Santa Cruz Mountains. It is of a dun color, rather friable, fine grained. With acids it effervesces slightly, and yields to them about 1.75 per cent of lime, showing that the soils influenced by it will be supplied with that important soil ingredient.

ANALYSES OF WATERS.

[Regarding water examinations, which are very laborious when exhaustive, it should be understood, that while the Department will examine samples sent to the extent of determining the general character by a "qualitative analysis," and the number of grains of solid matter contained per gallon, full analyses can be undertaken only in cases of public interest.]

Water from a spring on the Temblor Ranch, in the Coast Range, fifty miles from Bakersfield, Kern County, forwarded with request for examination by W. H. J. Brooks, Secretary Kern Valley Improvement Association. The water is clear, has a strong odor of sulphuretted hydrogen, and a faintly saline taste. On standing exposed to the air it becomes turbid, from the deposition of sulphur and of the carbonates of lime and magnesia. On evaporation, it leaves a saline residue amounting to seventy-five grains per gallon, mostly again soluble in water. This soluble portion consists chiefly of chlorine of sodium or common salt, with a small amount of chloride of potassium. The white powder remaining, and difficultly soluble, consists of the carbonates of lime and magnesia, with some gypsum or sulphate of lime. The water is, therefore, a "saline sulphur," of slightly purgative properties. It is stated to have been used with great benefit by many persons.

Water from a bored well on Bolsa Chica Rancho, Los Angeles County, sent by M. J. Wicks, of Los Angeles. "The stratum of mineral water was found at the depth of one hundred and sixty feet, and rose to thirty-seven feet of the surface. It is within one hundred feet of the ocean at high tide." The water is slightly turbid, smells strongly of sulphuretted hydrogen, and has a slightly saline, flattish taste. On evaporation, it leaves a saline residue amounting to 77.8 grains per gallon. This residue consists chiefly of the chlorides of sodium (common salt), magnesium (bittern), and calcium, with traces only of sulphates, and small amounts of potash salts, iron and alumina. These constituents are those of sea water, much diluted and somewhat changed by contact with strata containing vegetable remains. While of about the same saline strength as the water of Tulare Lake, the ingredients are much less injurious to vegetation.

Water from the Aptos Mineral Spring, sent by B. C. Nichols, of Aptos. Clear, of flattish, faintly saline taste; reaction slightly acid. On evaporation leaves a residue amounting to one hundred and fifty grains per gallon, which is again completely soluble, and consists chiefly of the sulphates, and partly of the chlorides, of sodium, magnesium, calcium, potassium, with some potassium salts, and small amounts of alumina and iron; thus combining slightly astringent properties with the purgative ones of the predominant ingredients.

Water from a well four miles west of Norwalk, Los Angeles County, from the land of Mr. Theodore Knoll. The land is level, and is considered bottom land, and is somewhat tainted with "alkali." The well was sunk to twelve feet depth, and at ten feet, gravel was struck as in the river bottom, with a copious flow of water—the latter rising four feet in the well. The examination was desired in order to determine whether the water could be used for irrigation.

The water is clear when fresh, but becomes slightly turbid on standing or boiling; on evaporation leaves a residue amounting to 40.4 grains per gallon, composed as follows:

Carbonate of soda	0.30
Common and Glauber's salts, etc.	25.65
Carbonates of lime and magnesia, silica, etc.	10.30
Organic matter	4.10
Total	40.35

In the soluble portion, the Glauber's salt is the chief ingredient. This examination shows the water to contain more than four times as much of solid ingredients as is usually contained in river waters. Of this, one fourth is innocent or beneficial, the rest undesirable, and doubtless the same as the alkali contained in the soil itself. If used for irrigation the water must be so managed that, from time to time, an at least partial leaching out of the soluble matters accumulated by evaporation shall occur, so as to carry the injurious excess back to the water table, out of reach of the roots. It would probably be sufficient to do this every four or five years, provided the carbonate of soda is neutralized by the use of gypsum, which need not exceed two hundred pounds per acre; or the water may be run through a sluicebox containing plaster before it reaches the soil.

A valuable additional contribution to our knowledge of the river waters of the State, in relation to their fitness for irrigation, has been made by Mr. Horace G. Kelsey, of Merced Falls, who made the subject the theme of his graduating thesis. An abstract of the latter is therefore here subjoined:

ANALYSIS OF THE WATERS OF SOME CALIFORNIA RIVERS,

With a view to the determination of their quality for Irrigation.

By Horace G. Kelsey, Ph. B., University of California, 1881.

Over a great portion of California, irrigation is absolutely necessary to insure annual returns for annual labor on the soil; that is, irrigation is required to insure the production of crops of any kind every year without failure. Over a still larger section of the State, irrigation, if not absolutely necessary to insure the yearly production of all crops, is beneficial to all and necessary to the non-failure of some. And over another section it is, if not beneficial to all crops, at least helpful to many of them. Irrigation is, therefore, one of the greatest questions with which the California farmer has to deal, and the institution of a proper system of irrigation throughout the State, wherever feasible, in such lands as stand in need of it, will be of great advantage. A large portion of the State is supplied with an abundance of water in the form of lakes and never failing rivers. All it lacks is a proper system of economizing and distributing those supplies which are fit for irrigation, immense volumes of which, on their way to the Pacific Ocean, are now flowing through rich lands, which now, from lack of moisture, remain for long periods parched and barren.

Among the first things to be done before using any water for extensive irrigation, should be to determine the nature of the solid substances which it contains in solution. It would be folly, except under rare conditions, to irrigate extensively with water containing any large quantities of substances which are deleterious to plant life. And even waters which contain what would seem to be almost inappreciable quantities of such substances, may eventually injure soils

which are not either naturally or artificially well drained, if irrigation be continued long enough.

We see instances of almost utter ruin, for the time being, of large tracts of land in India, from long continued irrigation with such waters. In our own State, the region about Tulare Lake furnishes a similar example. In this case the water used is quite rich in solid ingredients, of which a considerable part is the very deleterious carbonate of soda. Prof. Hilgard has shown by analyses of the waters of Tulare and Kern Lakes that they are utterly unfit for extensive irrigation on any soil which has not the most perfect natural or artificial drainage, so that it may at short intervals be thoroughly drenched and leached of all undue accumulation of soluble ingredients left there by the evaporating waters.

In consideration of the importance of irrigation to our State and of the disastrous results which have followed, and are sure to follow, the indiscriminate use of waters unfit for irrigation, it was deemed important to investigate the chemical composition of the waters of some of our rivers, apprehending that some of them might be similar in character to those of Lakes Tulare and Kern. This work taken up by me is a continuation of work begun in the Agricultural Department under the direction of Prof. Hilgard.

The tabulated results will be found in the following tables, the analyses marked with an asterisk having been made by the Agricultural Department, while my own work comprises the analyses of the waters from the San Joaquin, Merced, and Mokelumne Rivers, together with a partial analysis of a sample from Kings River.

The Mokelumne River sample was taken at Woodbridge, San Joaquin County, by Mr. Jas. W. Cowden, in November, 1880; that from the Merced, at Snellings, Merced County, by Mr. E. Kelsey, in December, 1880. Both samples were taken after the first rains, and contained small amounts of clay in suspension. The sample from the San Joaquin was taken at the railroad crossing, Sycamore Station, Fresno County, in December, 1880; it was clear, though likewise taken just after the rains had begun. The Kings River sample was taken at Kingsburg, Fresno County, by Mr. E. J. Draper, in November, 1880; no rain had fallen up to that date, and the water was clear.

TABLE I.

Showing general composition of California river waters.

	Grains per Gallon of—				
	Total Residue.	Carbonate of Soda.	Common Glauber's Salts, etc.	Carb. Lime, Magnesia, Silica.	Vegetable Matter.
Los Angeles River*	17.53	----------	8.37	9.16	--------
Kern Lake†	211.50	64.37	115.41	9.29	22.43
Kern River (cañon)†	9.49	1.22	1.77	5.55	.95
Tulare Lake (south end)†	84.44	27.92	37.85	13.44	2.28
Kings River†	4.13	0.003	0.86	3.27	--------
Kings River	5.02	?	?	?	.19
San Joaquin River	4.54	.45	.15	2.15	.59
Merced River	5.88	.19	.09	4.17	?
Mokelumne River	6.97	----------	.42	4.41	.37
Sacramento River*	6.69	.27	1.42	5.00	--------

* Analyses made for State Board of Health by Walter Jones, Class of 1878.
† Analyses for Agricultural Department of the University.

TABLE II.

Showing details of composition of California river waters.

GRAINS PER GALLON OF—	Los Angeles—City Hydrant, River Water	Tulare Lake—Middle, ten feet below surface	San Joaquin River.	Merced River	Mokelumne River.	Sacramento River—City Hydrant
Carbonate of soda		30.46	0.45	0.19		0.27
Chloride of sodium (common salt)	1.004	20.27	0.91	0.47	0.78	1.42
Sulphate of sodium (Glauber's salt)	4.134	7.54	0.15	0.09	0.42	
Sulphate of potassium			0.26	0.30	0.32	
Carbonate of lime	0.382	2.49	0.97	1.25	2.06	0.31
Carbonate of magnesia	4.287	4.21	0.15	1.42	0.85	0.25
Chloride of magnesium					0.10	
Silica	1.171	0.69	1.03	1.50	1.50	1.85
Sulphate of lime	0.776		0.02	0.59	0.51	0.42
Phosphate of lime	2,182					1.48
Iron and manganese carbonates	0.259		0.01	0.05	0.04	0.63
Alumina	*0.100	0.29				0.07
Vegetable matter		4.41	0.59		0.37	
Total residue	17.530	81.83	4.54	5.88	6.97	6.69

*From dissolved clay.

It would appear from these analyses (see Table I), that as we go south from the Mokelumne the carbonated alkali in the river waters gradually increases in amount until we reach Kings River, where it suddenly drops to a mere trace. Beyond this point the increase again appears and becomes very prominent in the water of Kern River. It is worthy of note, also, that southward to Kings River there is a gradual decrease in total solid contents, but further south the river waters progressively increase in solid constituents.

A consideration of Table II shows the somewhat remarkable fact, that although the river waters become more and more alkaline as we go southward, yet the dissolved silica which they contain not only does not proportionately increase but in some cases even diminishes.

The fifth column of Table I represents in each analysis that part of the total residue left by evaporating water which, by reason of its slight solubility, becomes more or less permanently fixed in the soil, and which is not injurious, viz.: silica and the carbonates of lime and magnesia. The remaining soluble portions only can be considered dangerous to plant growth, and the more so in proportion as the carbonate of soda is in excess of the comparatively harmless chloride and sulphate. In this view of the case, it will be seen from Table I that the residue from the waters of either the Merced or San Joaquin, though containing less carbonate of soda than any of the other river waters, would yet be more caustic on account of the predominance of the carbonate over the sulphate.

The solid contents of river waters usually vary from about five to twelve grains per gallon. In the waters of the Mokelumne, Merced, San Joaquin, and Kings, the range is from about four and one half to seven grains per gallon, which would class these waters as quite pure.

It is not generally supposed that a soil is fertilized to any extent by the substances held in solution by natural flowing waters, the enrich-

ing qualities of rivers being attributed almost wholly to suspended sediments deposited on the soil during overflow. It will not be difficult, however, to calculate the value of one of these clear waters as a fertilizer. Let us suppose that water from the Mokelumne River be applied to a growing grain crop in amount equal to ten inches of rain, that amount being required to insure the crop. This would equal 6.66 gallons per square foot of surface. Turning to Table II, we find that each gallon of Mokelumne River water contains of—

Sulphate of lime	.51 grains.
Sulphate of potassium	.32 grains.
Carbonate of lime	2.06 grains.
Total	2.89 grains.

Thus, in the 6.66 gallons applied to each square foot, we should have $2.89 \times 6.66 = 21.07$ grains, equal to 103 lbs. per acre of good plant food, and of this 103 lbs. over five consist of potash, and about twenty of sulphuric acid, two of the most valuable and yet most limited of soil ingredients. According to Johnson, we here have about one fourth the amount of potash, and more than five times as much sulphuric acid as would be required for a crop of thirty-three bushels of barley per acre; and the other articles of plant food not here mentioned are likewise found to be in excess for the above crop in the quantity of water suggested. Beyond doubt, then, these soluble matters will materially assist in maintaining the productiveness of our soils.

As to the fitness of these river waters for irrigation, to determine which was the main object of this investigation, the analyses show that the water of the Mokelumne, as it contains no carbonate of soda at all, can safely be used on any soil, no matter how poorly drained, for its other contained salts are quite harmless, unless present in great excess. The waters of the Merced and San Joaquin, however, do contain small amounts of carbonate of soda, but it is not likely that any evil results would follow their use in irrigation, owing to the very small quantities in which they are present. Supposing a soil to be underlaid by an impervious stratum at such a distance from the surface that, during the dry season, all the water resting upon it could be drawn up by capillarity to the surface, the result would be that during the summer months all the alkali in the water would be concentrated in say the upper two inches of the soil. Now, supposing that there is no drainage at all, and that ten inches of San Joaquin River water are yearly applied, how long would it take to render that soil alkaline? A soil which contains the quarter of one per cent of carbonate of soda may fairly be so called. The weight of an acre of common arable soil to the depth of two inches is 583,333 lbs., and 25 per cent of this gives 1,458 lbs. as the weight of carbonate of soda which must accumulate in each acre before the soil may be considered alkaline. Ten inches of San Joaquin River water would leave a yearly residue of 18.4 lbs. carbonate of soda per acre—$1{,}458 \div 18.4 = 75\frac{1}{2}$—*i. e.*, it would take 75½ years for San Joaquin River water, applied under the most unfavorable conditions, to produce injurious alkalinity in a soil.

There are probably but few soils in the State whose natural drainage is so poor, and in which the other conditions of an impervious stratum and long continued dry seasons are so realized, as to permit

even approximately so rapid an increase of alkali as calculated in our suppositious case. We must then conclude that with soils drained even moderately well naturally—or, if there be no natural drainage, with soils in which merely the artificial drainage necessary to keep irrigated lands in good physical conditions under any circumstances, is kept up—there can be little danger of their becoming alkaline from the use of the waters of rivers like the San Joaquin and Merced.

ANALYSES OF AGRICULTURAL PRODUCTS.

No. 1. *Sugar cane*, grown in Tulare County, sent January 6, 1881, by Charles A. Wetmore, Esq., San Francisco.

No. 2. "*Early Amber*" *cane*, grown six miles above Rio Vista, Sacramento County; sent by Maximilian Taubles, 215 Front street, San Francisco. The stalk was cut August 5, 1881, forty-two days after planting. Arrived at the laboratory August 12th, and, owing to its having been exposed to the air for one week after cutting, it was somewhat dry. Analyzed August 12th.

No. 3. "*Early Amber*" *cane*, from Isleton, Sacramento County, sent by M. Taubles. Planted May 15, 1881, cut August 22, 1881. Analyzed August 24th. Average height, nine feet six inches; thickness of stalk, one inch. The sample analyzed was from four stalks.

	Specific Gravity of Juice.	Solid Contents in Juice.	Percentage of Cane Sugar.	Purity Coefficient.
1. Sugar Cane	1.076	18.4	16.9	92.93
2. Early Amber	1.072	17.59	4.32	24.56
3. Early Amber	1.068	16.41	10.87	66.24

The above analyses exhibit, first, the superiority of the true sugar cane over the sorghum in respect to purity as well as total sugar contents, although in both respects the former is here shown below the quality to which it attains in tropical countries. There can be no doubt that wherever the tropical sugar cane can be grown to advantage, within the reach of intelligent labor and perfected appliances, it is superior to the sorghum as a sugar-producing plant. There can now, also, be no doubt that the sugar cane can be successfully grown not only in the southern division of the State, south of the Sierra San Fernando, but also in a considerable portion of the San Joaquin Valley, say within the Counties of Tulare and Kern, if not in a portion of Fresno. Its culture in small patches, in Los Angeles and San Diego Counties, has long shown that it is at home there. The only question remaining is, whether the commercial conditions of California will justify its culture on the larger scale, in competition with the Hawaiian Islands, and with the claims of other profitable products upon the attention of our farmers.

As to the sorghums, both samples here reported are considerably below the average of the tests before made with the same plant, and reported upon heretofore (see Report for 1880, p. 41), in which Early Amber cane from Bakersfield, cut when the seed was fully in dough, showed a sugar percentage of over fifteen per cent, and a purity

coefficient of 76.6; and results only a little less favorable were obtained from Amber cane grown on the University grounds. It would thus seem that from some cause, either the Sacramento Valley is not favorable to the development of the saccharine substances, or else, what is more probable, that either the seed or the cultivation were at fault in producing the indifferent results here shown.

In regard to sorghum, as well as the true sugar cane, it is not the question of the production of a good raw material for sugar making, but the peculiar commercial status of the sugar trade in this State, that stands in the way of the development of the home production of sugar on the large scale. That this is true as regards beets, no less than in respect to the canes, has been proved by the results given in previous reports, showing that beets of excellent quality have been grown from Sacramento to Los Angeles, already. The fact that good results have also been obtained in Washington Territory, proves that so far as the climate is concerned, the entire coast may be accounted adapted to sugar beet culture. Of course, the same is not true of all soils occurring within these limits, as has been shown in the case of some beets grown in San Luis Obispo and Santa Barbara Counties (see Report for 1879, p. 56; Report for 1880, p. 54); and it is again seen in the subjoined assay of *beets* grown in Humboldt County, on bottom land of Eel River.

Specific gravity of juice by spindle	1.05
Amount of solid matter corresponding (if sugar)	11.85
Amount of solid matter by direct determination	12.25
Percentage of sugar in juice	8.51
Purity coefficient	71.82
Total ash percentage in juice	.93
Insoluble part of ash	.23
Soluble part of ash	.70

Alkalinity of soluble part of ash corresponds to 0.171 caustic soda, which, in evaporation, would render 1.463 per cent. of sugar uncrystallizable.

The juice of these beets is altogether too poor in sugar and too impure for profitable working. But the unfavorable outcome of a single experiment should not discourage a repetition of similar trials in other locations, and, perhaps, with other seed. Alkali lands should in all cases be avoided when sugar production is in question.

Ensilage, sent by John W. Greene, of Hollister, San Benito County. This ensilage was made of green barley, in a silo apparently well constructed, and properly packed. When used in feeding ten horses for three weeks, one was found dead in the corral in the morning. The others sickened and died, by twos and threes, shortly after. Among them was a mare with a sucking colt, which also ate, but sustained no injury. It was desired to know what caused the trouble—whether a poisonous weed intermixed, or poison purposely introduced, or other cause. The first sample received was very mouldy, and Mr. Greene was advised of the fact that this alone would account for the sickening of animals eating it; but that if this was not its original condition, he must send samples put up in alcohol, so as to prevent the formation of mould in transmission. Such samples were received and subjected to examination for all metallic poisons, as also for strychnine and other commercially available vegetable poisons, but none of these were present, nor was there, among the few weeds associated with the barley, any one that could be suspected of poisonous properties. It being well established that ensilage, as such, when

well prepared and not allowed to mould, does not produce any such effects, the mortality produced by the use of Mr. Greene's ensilage remains a mystery, which could probably have been solved only by a close examination, on the spot, of the troughs, water, etc., used in feeding. From the fact that some animals continued to eat the ensilage with impunity, while and after others sickened and died, it seems probable that some poisonous substance was, from time to time, either accidentally or purposely introduced into the feeding troughs, thus not reaching all at the same time, and some not at all.

Apart from the heavy loss thus inflicted upon Mr. Greene in the loss of all his horses, and even of some belonging to others, this occurrence is deplorable in that it has given a "set-back" to the rational use of ensilage in this State; it being difficult to remove from the public mind the impression that "ensilage is dangerous." This is the more unfortunate, because of the special importance attaching to its possible use as dairy feed, in cases where the maintenance of pasturage during the dry season is difficult or impossible. It is to be hoped that the prejudice engendered by this untoward event will be removed by a calmer consideration of the ample experience had in this matter elsewhere, and of the advantages offered by the ensilage process in storing what is substantially fresh feed, against the season when otherwise stock may be reduced to cropping dry herbage or being fed with hay. Mr. Greene's experience may probably be classed in the same category with that of the wholesale poisoning of the customers of a London baker, who innocently used for fuel in his bake-oven, old boards that had been painted with white lead.

ORANGES AND LEMONS.

But few examinations of these fruits have been made during the past two seasons. The following are of some interest:

Seedling Orange from Mr. Jasper's place, Yuba County. This orange was interesting as coming from a locality very far north for its kind. They were received January 24, 1881, but not being entirely ripe were allowed to lie for a month and then examined. They were rather under size, as shown by their light weight, and somewhat thick-skinned; flavor good, but acid rather high.

"*Bonnie Brae*" *Lemon*, grown on Mr. Higgins' place, San Diego County, received and examined April 21, 1880.

	Total wt. in Grms.	Pulp, per cent.	Skins, per cent.	Specific Gravity.	Amount Solid Matter.	Acid, per cent.	Sugars.	
							Cane, per cent.	Levulose, per cent.
Seedling Orange	131.1 117.6	76.1 70.8	23.9 29.2	1.051	12.6	2.270	3.60	1.35
Lemon	126.0	85.0	15.0	1.036	9.0	5.403	0.60	0.44

Comparing these results with those given in previous reports, we find that as regards the oranges, their acid is very high as compared with the fruit from Riverside, being about one half more; while the total of sugars is only somewhat over one half of that of the south-

ern grown fruit. Of course, this may be a mere matter of accident, true only as regards this particular variety. In the oranges grown by Dr. Strenzel, near Martinez, the differences, if any, must be very much smaller, since their sweetness is rather remarkable to the taste. A test of these will be made before long.

The "Bonnie Brae" lemon, though very agreeable to the palate, falls considerably below the average as regards its acid, and would not rank high in market in this respect; the average acid percentage of California lemons being somewhat above seven.

APPENDIX II.

REPORT ON INSTRUCTION GIVEN; AND CULTURE EXPERIMENTS.

By Chas. H. Dwinelle, Lecturer on Practical Agriculture, and in charge of Field Experiments on the Agricultural Grounds.

Prof. E. W. Hilgard:

Sir: I herewith submit a report on instruction and other work in my department, including details of experiments with fertilizers on cereals.

Respectfully,

C. H. DWINELLE,
Lecturer on Practical Agriculture.

INSTRUCTION AND OTHER WORK.

In the regular course of study in the College of Agriculture, it is designed to give young men as much as is practicable, in the short space of four years, of that which shall fit them for the intelligent practice of agriculture, as well as some of that general culture which shall enable them to take their places as useful citizens of the commonwealth. The detailed schedule of studies is set forth in the Annual Register of the University, and can be obtained on application by any one desiring it.

Students in agriculture come regularly under my instruction in Senior year, although irregular, or special, students and visitors have, at times, attended my lectures for a longer or shorter period. During the first term, beginning in August, a course of lectures is given on the general principles of stock breeding, and their special application in the rearing of cattle, horses, and sheep. These subjects, with Mr. E. J. Wickson's course on dairy husbandry, occupy the first term. The second term is devoted to farm implements and machinery, principles and practice of tillage, irrigation, and drainage, and general field crops. Formal lectures are sometimes replaced by visits to the field and garden, or by excursions to farms, dairies, and other establishments, where the production and use of the fruits of the soil can be studied.

Our garden has added very largely to our specimens for object teaching, particularly in the subject of cereal grains. Friends in various parts of the State have also contributed liberally of specimens of grain, both in the head and cleaned.

In view of the great increase in numbers of insects, mainly of imported species, with which our agriculturists now have to contend, it has been thought best to make the study of Elementary and Economic Entomology one of the requirements of the College of Agriculture. I tried the experiment of giving my class a weekly exercise in this study. The results were so far satisfactory that, on

my recommendation, the Faculty formally incorporated this study into our agricultural curriculum. One hour per week is to be required of the Junior Class throughout the year.

The basis of instruction is Comstock's "Notes on Entomology," with references to Packard, Harris, Riley, and other standard authors, and lectures upon some of the more important of our Pacific Coast insects. Thus far I have voluntarily conducted these exercises, as there is no one else to take them in hand. It is greatly to be hoped, however, that the Chair of Entomology, long ago created by action of the Board of Regents, may at an early day be provided for by legislative appropriation or private liberality. The State could be greatly benefited if it were filled by one of the rising young economic entomologists for which the United States is becoming noted, and who are doing so much to redeem entomology, as a whole, from the reproach of being useless, which it, to some extent, deserved while in the hands of the advocates of pure science.

Our facilities for illustrating instruction and identifying specimens have been greatly increased by the acquisition of a very valuable collection of beetles, made by Mr. L. E. Ricksecker, of San Francisco. This was presented to the College of Agriculture, by J. M. McDonald, Esq., of San Francisco; Cutler Paige, Class of 1882, College of Agriculture; and Matthew Cooke, Chief Executive Horticultural Officer of California.

In the future our students in agriculture will have their chemistry earlier in their course than formerly. This will enable them to give more time to entomology and other studies which have very important bearings on their future calling.

We have the gratification of noting a gradual improvement in facilities for instruction and study. Not the least among these are the additions to our technical library, including besides treatises and reports on various subjects of interest to agriculturists generally, some exceedingly valuable works, by able authors, on such Californian specialties as the olive, citrus fruits, and ostrich farming.

Moving the lecture room and agricultural laboratory up stairs has greatly increased the comfort of all in this department.

A TWO YEARS' COURSE.

Some young men of good general education, graduates of academies, high schools, and the like, feel the need of a knowledge of those sciences which underlie intelligent agriculture, but cannot give four years to the regular course leading to a degree. These are encouraged to come and take a course covering two years, and including some of the more important branches for which their previous training has fitted them. If desired, they will receive a certificate stating what studies they have here pursued successfully.

PROFESSIONAL AGRICULTURE.

We believe that at this time the thorough study of Agriculture, as a profession in California, promises as great rewards as any other profession. No one who attacks the intricate problems involved in it need ever be in want of employment for his brain. Many of our most successful cultivators are college graduates, but educated under the old system. It is very common to hear them regret that they

had not just such facilities as are offered by the College of Agriculture. Here the principles are laid down; the details of practice must be learned mainly on the best farms.

This is strictly analagous to the other professions. The Law School is invaluable in its way, but it must be followed by years of drudgery to make a successful lawyer. So, too, in medicine. With the expenditure of an amount of time, labor, and money equivalent to that involved in the mastery of Law or Medicine, a young man should be well on the road to success in the higher branches of Agriculture, if he has the elements of success in him.

HORTICULTURAL AND OTHER WORK.

As a representative of the University on the Board of State Horticultural Commissioners, much of my time has been taken up during the past two seasons in studying the insect pests which injure fruit and fruit trees, and devising means for their extermination and to prevent the introduction and spread of new ones.

The Commission has met with encouraging success in arousing popular attention on this subject. At present it is trying to obtain judicial recognition of the right to quarantine insect infested trees, fruits, etc. Numerous experiments with insecticides have been undertaken on the University grounds. Some of these have already been reported upon in the publications of the Commission. The results of others, and of various trials of grain, forage plants, etc., will be formulated and published from time to time in such manner as may seem best calculated to reach the largest number of those interested.

DRAINAGE NEEDED.

The pressing want of our experimental grounds at present is underdrainage. Much of the best soil is practically useless, in an ordinarily wet year, on this account. The orchards, also, have suffered much from standing water. The tile needed would be furnished to the University on favorable terms.

SEED DISTRIBUTION.

The College of Agriculture from time to time distributes promising seeds of grains, grasses, etc., raised on its grounds. The recipients have been required to furnish the needed postage to send them through the mails, and to report results. We have the satisfaction of knowing that some of these plants have proved eminently adapted to the wants of the regions to which they were sent.

FIELD EXPERIMENTS WITH FERTILIZERS.

Tables I, II, III, and IV correspond to those bearing the same numbers in the reports of this institution for 1879 and 1880. It will be remembered that in the season of 1878–79, these series of plots were dressed with various fertilizers, and cropped with wheat and oats, which were harvested and thrashed. The following season no

fertilizers were used, while wheat and oats were again sown, but with their relative positions reversed, and cut early and cured for hay. The experience of those two years proved that our well worn soil could be brought up to a satisfactory state of productiveness by liberal applications of certain commercial fertilizers. Some showed a very handsome profit over all the expenses involved. Others gave no return that would warrant their use under the existing circumstances. These latter have been discarded.

During the season of 1880–81, experiments on the plots represented by the above tables were continued with wheat and oats cut for hay. To test the feasibility of keeping up at moderate cost the condition of land already improved by the addition of bone meal and lime these dressings were used in half the quantities of two years before.

They were sown broadcast after plowing, and harrowed in. On plots 10, Table II, and 6, Table III, on which gypsum had been used with little effect, a full measure of bone meal was used, that is, at the rate of six hundred pounds per acre. In place of the too expensive ammonia sulphate, was substituted sodic nitrate (Chili saltpetre), at the rate of two hundred and forty pounds per acre.

TIME OF SOWING AND HARVESTING.

The eastern series was seeded on the eleventh of January, 1881, and the western series on the twenty-fifth of the same month. The crop on both was cut about the middle of June, while in the dough, and cured for hay. Wheat was sown at the rate of ninety pounds to the acre, and oats at the rate of one hundred pounds. It is to be regretted that the portion of the western series devoted to oats should have been injured by a heavy rain during its early growth, so that it was valueless for comparative estimates, and was, therefore, rejected.

PREPARATION OF SEED GRAIN.

It is our practice to exercise considerable care in the preparation of seed grain, aside from the choice of superior varieties and well grown lots. After careful winnowing it is thrown, a little at a time, into a saturated brine of common salt. The heavy grain sinks to the bottom, while imperfect kernels and weed seeds float on top, and are removed by skimming. To guard against smut, the seed grain is soaked in a solution of bluestone for several hours, usually from five to ten, drained of its liquid, and made dry enough to sow by dusting with lime and shoveling over until every kernel is coated. After such preparation, grain may be kept for weeks without injury, in anticipation of good weather for sowing.

The eastern series, Tables III and IV, lie next to the orchard, and are numbered from south to north. The western series, Tables I and II, lie next the fence on the western boundary of the University grounds, and are numbered from south to north. The fertilized plots, and those alternating with them in the outside tiers, contain $\frac{1}{20}$ of an acre, 4 rods by 2, while the central unmanured tiers, designated as 1½, 2½, etc., are but $\frac{1}{40}$ of an acre in area. For convenience in comparison, however, the products of these half plots have, in all cases, been multiplied by 2 in making up the tables, so that we have to deal uniformly with $\frac{1}{20}$ of an acre.

The fertilizers used are noted, with the amount applied to each plot, and also the rate and cost per acre. The cost of the fertilizers is reckoned on a basis of their net cost delivered here in quantities of one or more tons, and not the actual cost of such small quantities as were used.

TABLE I.

Culture Experiments with wheat and oats raised for hay, 1880–81. *Western series. Kind, amount, and cost per acre of fertilizer used. Weight and rate per acre of product. Increased value of crop per acre. Plots 2 rods by 4=$\frac{1}{20}$ of an acre.*

OATS.	(Plot 1.) Unmanured.	(Plot 2.)	(Plot 3.) Unmanured.	(Plot 4.)	(Plot 5.) Unmanured.	(Plot 6.)	OATS.
	(Plot 1½.) U	(Plot 2½.) N M	Plot 3½.) A	(Plot 4½.) N U	(Plot 5½.) R	(Plot 6½.) E D.	
WHEAT. Hay..	(Plot 1½.) 182lbs.—1.82 T. per A.	(Plot 2½.) 136lbs.—1.36 T. per A.	(Plot 3½.) 127lbs.—1.27 T. per A.	(Plot 4½.) 221lbs.—2.21 T. per A.	(Plot 5½.) Low spot. Rejected on account of weeds, etc.	(Plot 6½.) 142lbs.—1.42 T. per A.	WHEAT.
Hay..	(Plot 1.) Unmanured. 219 lbs.—2.19 T. per A.	(Plot 2.) 12lbs.—240lbs.@$7 44 per A. Chili saltpetre—sod. nitrate. 330lbs.—3.30 T. per A. Increased val. in 1881, $22 95.	(Plot 3.) Unmanured. 223lbs.—2.23 T. per A.	(Plot 4.) 15lbs.—300 lbs. @$4 87 per A. Bone meal. 366lbs.—3.66 T. per A. Increased val. in 1881,$26 40.	(Plot 5.) Low spot. Unmanured. Rejected.	(Plot 6.) 25lbs.—500 lbs.@$3 64 per A. Lime. 283lbs.—2.83 T. per A. Increased val. in 1881, $11 85.	

TABLE II.

Culture Experiments with wheat and oats raised for hay, 1880–81. Western Series. Kind, amount, and cost per acre of fertilizer used. Weight and rate per acre of product. Increased value of crop per acre. Plots 2 rods by 4=$\frac{1}{20}$ of an acre.

	OATS.	(Plot 7.) Unmanured.	(Plot 8.)	(Plot 9.) Unmanured.	(Plot 10.)	(Plot 11.) Unmanured.	(Plot 12.)
	OATS.	(Plot 7½.) U	(Plot 8½.) N M	(Plot 9½.) A	(Plot 10½.) N U	(Plot 11½.) R	(Plot 12½.) E D.
Hay......	WHEAT.	(Plot 7½.) 273lbs.=2.73 T. per A.	(Plot 8½.) 170lbs.=1.70 T. per A.	(Plot 9½.) 196lbs.=1.96 T. per A.	(Plot 10½.) 172lbs.=1.72 T. per A.	(Plot 11½.) 180lbs=1.80 T. per A.	(Plot 12½.) Rejected.
Hay......	WHEAT.	(Plot 7.) Unmanured. 197lbs.=1.97 T. per A.	(Plot 8.) 15lbs.=300lbs@$4 87 per A. Bone meal. 218lbs.=2.18 T. per A.	(Plot 9.) Unmanured. 245lbs.=2.45 T. per A. Chaff burned here in 1879. Hence the good yield.	(Plot 10.) 30lbs=600lbs@$9 75 per A. Bone meal. 193lbs=1.93 T. per A. Soil shallow.	(Plot 11.) Unmanured. 220lbs=2.20 T. per A.	(Plot 12.) Lime. Rejected.

TABLE III.

Culture Experiments with wheat and oats raised for hay, 1880–81. *Eastern series (top of ridge.) Kind, amount, and cost per acre of fertilizer used. Weight and rate per acre of product. Increased value of crop per acre. Plots 2 rods by* $4 = \frac{1}{20}$ *of an acre.*

WHEAT.	Hay......	(Plot 1.) 15lbs.=300lbs.@$4 87 per A. Bone meal. 245lbs.=2.45 T. per A. Increased val. in '81, $10 20.	(Plot 2.) Unmanured. 175lbs.=1.75 T. per A.	(Plot 3.) 12lbs.=240lbs.@$7 44 per A. Chili saltpetre, sod. nitrate. 246lbs.=2.46 T. per A. Increased val. in '81, $13 05.	(Plot 4.) Unmanured. 138lbs.=1.38 T. per A.	(Plot 5.) 25lbs.=500lbs.@$3 64 per A. Lime. 175lbs.=1.75 T. per A. Increased val. in '81, $3 15.	(Plot 6.) 30lbs.=600lbs.@$9 75 per A. Bone meal. 232lbs.=2.32 T. per A. Increased val. in '81, $9 15.
WHEAT.	Hay......	(Plot 1½. 172lbs.=1.72 T. per A. U	(Plot 2½). 184lbs.=1.84 T. per A. N M	(Plot 3½.) 164lbs.=1.64 T. per A. A	(Plot 4½.) 136lbs.=1.36 T. per A. N U	(Plot 5½.) 170lbs.=1.70 T. per A. R	(Plot 6½.) 172lbs.=1.72 T. per A. E D.
OATS.	Hay......	(Plot 1½.) 147lbs.=1.47 T. per A.	(Plot 2½.) 163lbs.=1.63 T. per A.	(Plot 3½.) 139lbs.=1.39 T. per A.	(Plot 4½.) 114lbs.=1.14 T. per A.	(Plot 5½.) 124lbs.=1.24 T. per A.	(Plot 6½.) 171lbs.=1.71 T. per A.
OATS.	Hay......	(Plot 1.) 15lbs.=300lbs.@$4 87 per A. Bone meal. 209lbs.=2.09 T. per A. Increased val. in '81, $8 82.	(Plot 2.) Unmanured. 130lbs.=1.30 T. per A.	(Plot 3.) 12lbs.=240lbs.@$7 44 per A. Chili saltpetre, sod. nitrate. 209lbs.=2.09 T. per A. Increased val. in '81, $9 38.	(Plot 4.) Unmanured. 164lbs.=1.64 T. per A.	(Plot 5.) 25lbs.=500lbs.@$3 64 per A. Lime. 144lbs.=1.44 T. per A.	(Plot 6.) 30lbs.=600lbs.@$9 75 per A. Bone meal. 231lbs.=2.31 T. per A. Increased val. in '81, $11 76.

TABLE IV.

Culture Experiments with wheat and oats raised for hay, 1880–81. *Eastern series continued.*

WHEAT.	Hay--	(Plot 7.) Unmanured. 228lbs.=2.28 T. per A. (Limed in 1876.)	(Plot 8.) Lime. Rejected.	WHEAT.
WHEAT.	Hay--	(Plot 7½.) 251lbs.=2.51 T. per A.	(Plot 8½.) Rejected.	WHEAT.
		U N M A N	U R E D.	
OATS.	Hay--	(Plot 7½.) 242lbs.=2.42 T. per A.	(Plot 8½.) Rejected.	OATS.
OATS.	Hay--	(Plot 7.) Unmanured. 326lbs.=3.26 T. per A. (Limed in 1876.	(Plot 8.) Lime. Rejected.	OATS.

EFFECT OF BONE MEAL.

As to be expected on an undulating piece of land, such as the one under discussion, with variety in exposure, depth, and composition of soil, and drainage, there is no uniformity in the results from the use of a given fertilizer. In the western series, plot 4 shows a gain of 1.76 tons of hay as compared with the average of 3, 3½, and 4½. At $15 per ton, this gives an increased value of $26 40 per acre, gained at an outlay of $4 87 for bone meal applied, and 48 cents interest for one year, in all $5 35, leaving a balance of $21 05 profit. It certainly looks as though it paid to keep up the fertility of that soil.

If we set down the account with this plot for three years, it is about as follows:

Increased value of crop of 1878–9, wheat and straw, per acre		$8 28
Increased value of crop of 1879–80, oat hay		30 24
Increased value of crop of 1880–1, wheat hay		26 40
		$64 92
Cost of bone meal at 600 pounds per acre in 1878	$9 75	
Interest for one year	97	
Cost of bone meal, at 300 pounds per acre in 1880	4 87	
Interest for one year	48	
		16 07
Profit in three years		$48 85

The soil in this part of the experimental grounds is somewhat better than in some other parts, but it is by no means deep, nor what would be called a choice piece on most farms. The main reason why it shows more effect of the bone meal than others, seems to be that there is more moisture to act as a solvent.

Plot 8 does not show any remarkable gain, although it is better than the average. Plot 10, which was dressed for the first time with bone meal, gave but 1.93 tons per acre. This is exactly the average yield of all of the unmanured plots in this series. The soil of this plot is mostly very shallow, and subject to drought, so that no amount of fertilizing is likely to force it into great productiveness in an ordinary year. In the eastern series, Table 3, plot 1, of wheat, keeps up its old record as responding to good treatment by giving an increased crop of .68 tons of hay per acre, of the value of $10 20. This returns the outlay with interest, and leaves a profit for the year of $4 85. The three years record of this plot is as follows:

Increased value of crop of 1878–9, wheat and straw, per acre		$11 76
Increased value of crop of 1879–80, oat hay, per acre		6 12
Increased value of crop of 1880–1, wheat hay, per acre		10 20
		$28 08
Cost of bone meal, at 600 pounds per acre, in 1878	$9 75	
Interest for one year	97	
Cost of bone meal, at 300 pounds per acre, in 1880	4 87	
Interest for one year	48	
		16 07
Profit in three years		$12 01

The corresponding oat plot (1), was injured by small birds, when the crop of oats was maturing in 1879, so that its record is defective. As far as we have definite figures it is:

Increased value of crop per acre, 1878-9, oats and straw	$1 90
Increased value of crop per acre, 1879-80, wheat hay	3 00
Increased value of crop per acre, 1880-1, oat hay	8 82
	$13 72
Cost of two dressings of bone meal, and interest	$16 07

This leaves an apparent balance against the land of $2 35 per acre. In 1879, when the oat crop was lessened by birds, the stand of straw was so good that it would be safe to say that there should have been at least ten bushels per acre more of oats, worth $4. With this allowance, the bone meal has a little more than paid for itself, so that any increase which it may produce in the future will be profit.

Plots 6, which had formerly (1878) been dressed with gypsum with no marked benefit, were given a full dressing of bone meal, at the rate of 600 pounds per acre, costing $9 75 and interest 97 cents, in all $10 72. Comparing each one with the adjoining plots, 5½ and 6½, having similar soil, we find in the wheat plot the increased value of the crop is $9 15, leaving $1 57 to be made up on the next crop, while in the oat plot the increased value is $11 76, giving a clear profit of $1 04 the first year.

CONCLUSIONS AS TO BONE MEAL.

A careful review of our field experiments with this fertilizer leads to the conclusion that it is admirably adapted for renewing some of our soils, which have been impoverished by injudicious cropping. We may even go farther, and say that some soils at present giving good crops, could be dressed with bone meal with a very decided increase in the net profits derived from their cultivation. Very striking illustrations of this have been given in our garden of economic plants, which has a black, gravelly, clay loam, quite different in character from the clay soil of the ridge on which the above experiments were made. There, not only cereals but beets, turnips, onions, Jerusalem artichokes, etc., respond most satisfactorily to this fertilizer.

It is encouraging to note that instances of the profitable use of bone meal by our practical agriculturists, on a variety of soils, are multiplying. Thus Mr. Robert Ashburner, of San Mateo County, uses it on the very light soil of his dairy farm, on forage crops, mangels and maize, followed the next year by wheat for hay. Some vineyard and orchard owners are finding that bone meal is a tonic which will keep vines and trees in good heart, so that their fruit shall be abundant and fair. When their example is more generally followed, we shall hear less of the "running out of varieties," and "changes of climate," which render horticulture unprofitable.

To be sure this is all in accordance with the teaching of agricultural science, as developed in England and Europe, but as Californian experience it has its special value. It should go far towards destroying the somewhat prevalent idea that the natural laws which govern vegetable nutrition, and consequently profitable farming, are different here from what they are in other parts of the world. Without going deeply into the chemistry involved, the value of bone meal as a manure may be briefly stated as follows: The glue and other animal matters furnish nitrogen in a quickly available form. The lime in

combination, although not so active as that from the kiln, is similar to it in its effect upon vegetable nutrition. It is phosphoric acid, however, which gives bone meal its special value the world over, and particularly in California. As a result of numerous analyses of soils of this State, made in the laboratory of this institution, Prof. Hilgard states that a most remarkable feature is the almost uniformly low percentage of phosphoric acid. In the great interior valley soils the average is from seventy to eighty thousandths of one per cent (.070–.080 per cent), while a full supply would be from two hundred to two hundred and fifty thousandths of one per cent (.200–.250 per cent). Of course this means a serious reduction in productiveness at no distant day, if attention is not soon given to supplying the drain upon this slender stock through the yearly sale of crops. Prof. Hilgard further states that the almost universal abundance of lime in these same soils adds to the danger of their being cropped to exhaustion, the lime seeming to stimulate to production as long as a crop ration of phosphoric acid remains, as has been too frequently illustrated in the cotton fields of the South. Thus the failure to produce paying crops may be as sudden as it is unwelcome. The presence of the lime is an undoubted advantage in enabling a judicious farmer to make the most of his land, if he will keep up the supply of phosphates by a proper dressing, for example, bone meal. Some may claim that, if it be proved that bone meal is what our lands need to save them from bankruptcy, the available supply is far below the large areas to be treated. The reply to this is that there are now two factories in San Francisco where bone meal is produced, but that they are not overrun with orders from within the State is too evident from the following, taken from a recent letter from the proprietor of one of them: "We are having a very steady demand for our fertilizers, principally from the Sandwich Islands." "They are used on the cane lands with very good results." Let us hope that our farmers may become as keen in looking after their interests as the sugar planters are.

LIME.

Wheat plot 6, in the western series, compared with the average of plots 6½, 7, and 7½, shows an increased yield of .79 tons per acre, of the value of $11 85. The outlay for lime being $3 64, leaves a profit for the year of $8 21 per acre. The three years account with this plot stands as follows:

Increased value of crop of 1878–9, wheat and straw, per acre		$9 48
Increased value of crop of 1879–80, oat hay, per acre		6 12
Increased value of crop of 1880–1, wheat hay, per acre		11 85
		$27 45
Cost of lime at 1,000 pounds per acre in 1878	$7 27	
Interest for one year	72	
Cost of lime at 500 pounds per acre in 1880	3 64	
Interest for one year	36	
		11 99
Profit in three years		$15 46

Plot 12 was so injured by a Winter overflow and consequent influx of weeds as to be unfit for comparison with its neighbors..

In the eastern series, wheat plot 5, compared with 4, 4½, 5½, and 6½, shows an increased crop of .21 tons per acre, worth $3 15, gained at an

outlay of $3 64, leaving the land in debt 49 cents for the year. For three years the account is:

Increased value of crop of 1878–9, wheat and straw, per acre	$1 96
Increased value of crop of 1879–80, oat hay, per acre	6 96
Increased value of crop of 1880–1, wheat hay, per acre	3 15
	$12 07
Two dressings of lime and interest	11 99
Balance	$0 08

While the crops have been improved on this plot, there has been no profit to speak of.

Wheat plot 7, which has showed its superiority after the liming in 1876–7 each year, till this one, is not this time quite up to the adjacent 7½, having a similar soil.

Unfortunately plot 8 had to be rejected on account of an invasion of weeds.

Of oats, plot 5, as usual, has nothing of value to show for the cost of the lime, apparently because it does not possess those elements which are rendered more available by the disintegrating effects of lime. That it is plant food, and not a mere stimulant, that is wanted on this tier of plots, on the crest of the ridge, is plainly seen in comparing this plot with the two plots dressed with bone meal and one with Chili saltpetre. The average crop of these three is 2.16 tons per acre, or .72 tons better than plot 5.

On the other hand, as we descend from the ridge to plot 7, where the soil is deeper and darker colored, we still find the old dressing of lime of 1876–7 producing a marked effect.

SPECIAL FUNCTIONS OF LIME.

While lime is known to be an essential element in agricultural crops, it is not to this fact that we are to look for an explanation of the effect of its application upon our soil. Chemical analysis has shown that this soil, in common with most others throughout California, contains all of the lime which could be asked for, as far as its use as plant food is concerned. It is in its action in preparing other constituents of the soil for ready assimilation by plants, and in improving the tilth of otherwise stubborn lands, that its good services are mainly rendered. Soils rich in vegetable matter respond with peculiar readiness to treatment with lime. The lime produces rapid disintegration of the vegetable matter, and the carbonic acid derived from the latter enables the soil-water to dissolve the carbonate of lime, and distribute it through the soil, so as to render the latter more friable and less subject to drought. The results of the experiments before us are in accordance with these principles. The thin soil, which is very poor in vegetable mold, shows little effect from the liming. As we go from plot to plot, we find that any improvement in depth, and in amount of vegetable mold, has its counterpart in the greater efficacy of the liming.

There seems also to be an intimate connection between the presence of lime and the availability of the phosphoric acid which the soil may contain, as hinted at in speaking of bone meal. Other relations of this valuable element might be dwelt upon if space permitted, but what has been given above should be enough to make

the farmers of the State ponder seriously upon the availability of this dressing for their heavy soils. The following quotation relating to the source of supply of lime, is from the report of this institution for 1879:

Situated as we are at Berkeley, lime costs something over $14 per ton delivered on the ground, after deducting the value of the barrels. The above estimates are made on a basis of 7.27 mills per pound. This might be considerably reduced, if large areas were to be limed, by buying by the carload in bulk. Many farms are so situated that they can buy at the kiln at $6 or $7 per ton, or, perhaps, burn for themselves at a less cost. It is to be noted that stone which is not pure enough to make lime for masons' use, may do very well for the purpose in question. At kilns where first-class lime is sold there is usually a considerable amount of waste lime, mixed with wood ashes, which is not used, and could be had at trifling cost. It is to be hoped that farmers throughout the State, who can get lime at reasonable rates, will give it a fair trial on their clay lands, not only on grain but also on their pastures which have been overstocked, and perhaps poached by the trampling of stock in wet weather. In the latter case it should encourage the growth of clovers, as well as loosen up the clay. Where clods have formed under careless cultivation, the benefit would probably be very apparent.

The kilns from which the central portion of the State is mainly supplied with lime at present, are in El Dorado, Placer, and Santa Cruz Counties, a moderate quantity being also burned at Los Gatos, in Santa Clara County. There are, doubtless, many other localities where the necessary supplies of rock and fuel could be had to produce lime cheaply, and of sufficient purity for agricultural use. The farmer should bear in mind, however, that, while he is improving the tilth of his stiff soil by the application of lime, he must look mainly to other sources for that plant food necessary to keep up its strength under continuous crops, and avoid ultimate exhaustion.

CHILI SALTPETRE—SODIC NITRATE.

It has seemed very desirable to find some fertilizer besides barnyard manure that would furnish nitrogen at reasonable expense. Our wheat fields are so out of proportion to the number of animals kept, that in many cases it is useless to expect these latter to do much towards keeping them up. Chili saltpetre (sodic nitrate) commended itself as already having a high reputation in other parts of the world, and being available in our market, where it is sold to manufacturers of chemicals. At the time of beginning our experiments with it the price was abnormally high, on account of the war between Chili and Peru. The salt was selling at five cents per pound, whereas now it can be had in lots of a ton or over at three cents per pound. As this latter is the normal price, the estimates of the cost of a dressing have been based upon it.

Three plots were dressed with this fertilizer, which was applied to the growing grain in solution, at the rate of 240 pounds per acre, on the fifteenth of April, 1881. No attempt has been made to estimate the cost of applying, as this was done in a very different manner from any that would be practiced in a business way. It was sprinkled on by means of a watering pot. On the large scale a sprinkling cart would come in play, such as is commonly used in England, and on the Continent, for liquid manures; or, if thoroughly pulverized, the salt might be spread by means of a broadcast seed sower, just before a rain. If the fertilizer promises a profit, our mechanics can be trusted to find some easy means of applying it. We have heard of an attempt to use the salt on lawn grass without dissolving it, but it produced an injury instead of a benefit, as some spots received too much, and were corroded, while others received none. In the series of experiments before us, we find that the results are so good as to warrant further trial of this fertilizer by those having soils in need of nitrogenous manures.

The three plots dressed with Chili saltpetre had been treated two

years before with ammonia sulphate, which seemed to
pretty thoroughly exhausted by the succeeding crops.

In the western series, wheat hay plot 2, gives a crop
per acre, which, compared with the average of its five adj
shows an increase of 1.53 tons, of a value of $22 95, ga
outlay for material of $7 44, and interest on the sam
months, 50 cents, in all $7 94. This leaves $15 01 for co
cation and profit, which at the worst would be nearly 2
net return for the investment, to say nothing of a possi
succeeding crops.

In the eastern series, plot 3, of wheat, with a crop of 2.
acre, shows a gain over its five adjacent plots of .87
$13 05; leaving a balance, after deducting expenses, $7
Oat plot 3, gives .67 tons increase, worth $9 38, or $1 4
of cost.

It is not to the nitrogen which it contains, as quickl
plant food, that we are to ascribe all of the benefits from
this manure. As a solvent, it has a most important
preparing some of the most valuable elements of the
nourishment of crops. In this connection we can hardl
than quote so high an authority as Baron Von Liebig, wh

When the exhaustion of a field is not caused by the absolute deficiency of
when even more than adequate supply of all the needful nutriment is there,
proper form, and where consequently fallowing will again render the crop re
farmer has means at his disposal to assist the natural agencies whereby the co
food into the state of physical combination is effected, and thus to shorten the fa
or even, in many instances, to make it altogether superfluous.

We have seen that the diffusion of earthy phosphates through the soil is effe
by water, which, if containing a certain amount of carbonic acid, dissolves these

Now there are certain salts, such as chloride of sodium (common salt), nitrat
salts of ammonia, which experience has proved to exercise, under certain con
able action on the productiveness of a field.

These salts, even in their most dilute solutions, possess, like carbonic acid,
power of dissolving phosphate of lime and phosphate of magnesia; and when
are filtered through arable soil, they behave just like the solution of these
carbonic acid water. The earth extracts from these salt solutions the dissolve
phates, and combines with the latter.

* * * * * * *

Thus, chloride of sodium and the nitrates act in two distinct ways; one direc
food for the plant; one indirect, by rendering the phosphates available for
nutrition.

It thus becomes evident that Chili saltpetre is not a perf
since it enables a crop to take from the soil valuable elem
are not supplied by itself nor by the air and rain-water.
degree then, we must bear in mind the same warning
lime, and be cautious in its use, unless the maintenance
ply of phosphates be provided for. In English practice
izer has been found profitable more frequently upon
grasses than upon roots and clovers. It also has the repu
of enabling soils to resist drought, in the same way tha
by the fine disintegration of particles which it produces.

FARMERS' FERTILIZER EXPERIMENTS.

During the year 1882 the plots reported upon above ha
lowed, partly in order to free them from weeds and part

* Chili saltpetre.

expense. It is greatly to be regretted that a want of adequate funds forces us to drop most of our experiments in this direction. We hope to see our practical farmers take up this very important work where we leave it. Certainly they are interested in knowing whether or not each one of their broad acres can be made to produce several dollars more of net profit each year than it now does. By a little of that coöperation which is fortunately now so popular, much of value could be learned, at comparatively small cost to each of several neighbors. Let them buy a ton of some fertilizer promising improvement of their land, divide it, and apply it at a definite rate to plots which are each a definite fraction of an acre, harvest the crop by itself, and compare it with that of unmanured land about it. It is to be borne in mind that the soil here reported upon has been farmed about thirty years, so that the amount of a given fertilizer needed to bring it up to a respectable state of fertility is far greater than would be called for on most fresher lands. In one case, where analysis had demonstrated a deficiency of phosphates, under advice from this institution, excellent results were produced on a barley crop by a dressing of as little as two hundred pounds of bone meal to the acre. All results thus obtained should be published for the public good. They would be gladly received, from authentic sources, by the faculty of this institution, compiled and printed. This institution will be at the service of the farmers of California in analyzing soils and commercial fertilizers, and making suggestions as to soil improvements.

There is no doubt that much might be done towards controlling weeds of various kinds by the judicious use of fertilizers, not only in grain fields but in pastures. We may even find an antidote for the pestiferous barley grass or "fox-tail" (*Hordeum murinum*), which is so seriously injuring our grazing resources.

C. H. DWINELLE.

APPENDIX III.

REPORT ON FRUIT AND MISCELLANEOUS CULTURES.

By W. G. KLEE, Gardener in charge of the Experimental Grounds.

Professor E. W. Hilgard:

I hereby respectfully submit my report on the grounds under my charge, with the results of culture trials of a number of useful plants. Of these, such only as have been tried for some time will be dwelt upon, except where they are of more than ordinary importance. The results of the culture experiments with cereals and forage plants, which have also been under my direct supervision, will be reported on by Professor Dwinelle.

ORCHARD.

The experimental orchard planted in 1874, by Mr. John Ellis, was in 1880 put under the jurisdiction of the Agricultural Department, and has within the last two years commenced to bear. Its location, with exception of the portion occupied by plums and apricots, is far from being favorable, being underlaid by a heavy impervious clay and bed-rock, giving poor drainage in spite of considerable fall of the ground; it is a locality only to be made arable by artificial means. Its nature has, in the case of the cherries, caused a complete failure, the cold water remaining too long around the roots of the tree and causing root rot; so that out of one hundred and fifty cherry trees, consisting of about seventy-five varieties, only about twenty are alive now, in scattered groups, apparently favored by a little better drainage. As this section is well adapted for cherries, this failure is very deplorable, the collection having contained a number of new and valuable sorts.

APPLES.—The collection of apples consists of two hundred and twenty trees, of about one hundred and fifty varieties. Being in a similar location as that of the cherries, better drained but more exposed to the wind, the trees have made a rather poor growth. Last year the scale bugs (*Aspidiotus conchiformis* and *A. rapax*) increased enormously, and various remedies were resorted to, the results of which will be reported upon separately. The woolly aphis has also attacked the trees very severely, and active measures have been taken against them with more or less success. Owing to all the drawbacks, the apple trees are still at the age of nine years very backward.

As regards new varieties to be recommended, there are extremely few to be mentioned that have shown any superiority over the well-known varieties already cultivated extensively. Of early varieties I can only mention Tetofsky, a Russian apple, ripening in July. The tree is an early, good bearer, and probably for this reason, not a very vigorous grower; the apple is of medium size, round, smooth,

color yellow, striped with red, covered with a white bloom like the Astrachans, which it precedes considerably. The Duchess of Oldenburg is another Russian apple, also known as Smith's Beauty of Newark, or Brunswick, and in the East considered a good market apple. It ripens here about the time with the Astrachan, and is an early and abundant bearer. These two varieties are by no means new, but as it seems, little known in the State, and are no doubt worthy a place in the family orchard if not to be planted for the market. Of later ripening varieties, the old Pomme Royal, or Dyer's, deserves to be looked at in the same light. Of Winter apples, we have some that are new, and supposed to be valuable, but their merits can only be learned the coming season.

PEAR ORCHARD.—If the experience to be gained from the apple orchard is of comparatively little value as yet, the pears are so much the more promising. The pear orchard is located adjoining the apples, on a similar soil and next to the almost extinct cherry orchard; but in spite of this is on the whole in excellent health save a few trees attacked by scales, and some showing the woolly aphis on the root. It consists of two hundred and sixty trees, comprising one hundred and forty varieties, many of which are new and promising; some being particularly so, we have thought them worthy of closer description. I shall, therefore, only mention the names of these, referring for a detailed description to a separate chapter. On the whole, only those that I have had an opportunity to observe for two seasons will be dwelt upon.

The following is a list of some of the most promising. As regards the time of ripening given, it must be remembered that this locality is rather late, the Bartlett not ripening before the end of August or the beginning of September:

St. André, picked August twenty-sixth, ripe in ten days, keeping well, medium size, yellow, with red cheek; melting, buttery, and sweet.

André Desportes, Anne Augereau, Napoleon the Third, Souvenir du Congrés, Brockworth Park, and Calabasse Monstreuse are more especially described and figured below.

Paradis d'Automne, picked September twenty-fifth, ripe October seventh (1881); medium size to large; highly flavored; a good keeper.

De Tongres, medium size to large; beautiful red bronze color; highly flavored, vinous, but suffers from drouth here, and ripens, therefore, very irregularly; has ripened in August and also in October, when it apparently seemed to be picked too early. (In this case it was clearly not due to the fruit being set at a different time.)

Epine Dumas—Medium size to large; pleasant, juicy, subacid; picked September 28, 1881; ripe in the middle of October, keeping for fully a month in the ripe state.

Of other pears deserving a place in the family orchard, but not equal to those above, I shall mention a list, naming them according to the time they ripen: In August, Canandaigua; Gratiola of Jersey, in August and September; in September, Duchesse Precoce, Sheldon, Marie Louise d'Uccles; Bonne Sophie, small, but very sweet; Doyenne Robin, the largest bearer of all, fair size; October, Henry the Fourth, small, but fine; Beurré Amande, St. Germain; November, Md. Loriole de Barny.

As to pears well known in California, we can only add our testimony to their excellence. Of these the Howell stands at the head for yield,

size, and keeping qualities; Clapp's Favorite, a regular a
bearer; Bloodgood, Swan's Orange, Beurré Clairgeau
Doyenne d'Eté, Beurré Bosc, Beurré d'Anjou, Easter Be
Nelis, and others.

Only about one fourth of the varieties of the total num
have been observed for two seasons; somewhat more tha
the last one. Their character will be reported upon
great number of pears are here characterized by becom
ten, even before ripening. Soil and climate have n
good deal to do with this, and pears valueless here ma
other localities in the State, while those that thrive he
do at least as well elsewhere, in a good, strong loam, and
high a temperature.

Apricots.—The apricot trees have, so far as growth i
done exceedingly well, and a number have proved g
At the head of these stands the Blenheim, for vi
as for yield and good keeping qualities. It has bo
years in succession (planted 1874), one tree this year givi
300 pounds. Of other well known varieties, the Hemesk
best. Of new varieties, de Coulorge is a good bear
and large, something like the Moorpark, ripening at the
Kaisha is also an early bearer, fruit of good size, ripeni
tively evenly. St. Ambroise has a very fine, large fruit,
evenly. The tree being very vigorous, has not come int
as yet, but promises well. The Sardinian is a small,
bearing well, but fruit a little dry. The Purple Aprico
plum in appearance, is well enough for the variety, but t
owing, however, to its attractive color, it may be a good

Peaches.—Neither the climate nor soil in this local
ble to the peach; the soil, as before stated, is of too h
acter, and the chilly coast winds, coming right in fro
Gate, encourage all kinds of fungous growth. The te
are therefore here affected by curly leaf, and the gland
by mildew in a very high degree. Out of sixty-five varie
growing in the most protected part of the orchard, onl
said to have been exempt altogether from the curly l
Early Richmond, a fine yellow peach, ripening in A
variety of very poor quality, here misnamed Royal Geo
ber of others recovered, however, remarkably well, a
crops, especially the late yellow varieties, Comet, Jones
Solway, the first and the last particularly so; owing no
want of moisture in the ground, they were, however,
juiciness and somewhat bitter. Of early, comparatively
varieties, Hale's Early was perhaps the best; Haines
as Early Savoy recovering, also bear well; the two fir
during July with their well-flavored freestone fruit, the
beginning of August. Later in August, Belle de la C
White, Monstreuse of Douay, Walburton's Admirabl
Melocoton, and especially Foster, produced a fair quant
comparatively good size. To this list the somewhat
varieties, Raymackers, Prince of Wales, Acton Scot, and
Carpenter's White, must be added.

The Nectarines are growing, together with the pe
eastern slope comparatively well protected. Owing to
they are a complete failure. One variety, Duc de Vitr

nearly every year, and several applications of whale oil soap and sulphur to this and the other trees tended to show that this remedy, if taken in time, might be quite effective.

PLUMS have, next to apricots, proved to be better adapted to our climate and soil than any other fruit tree, and nearly all of the fifty-five varieties grown here, bore good crops; but exceedingly few that could claim any superiority over the many good varieties cultivated already in California, have been found. As a very early plum, the Ontario deserves mention. It is a seedling, originated by Messrs. Elwanger and Barry. It is a robust grower, and an early and abundant bearer; fruit large, oblong, greenish yellow, of a pleasant taste, ripening this year as early as the month of June (exceedingly early for this locality). Another still earlier variety is named Morocco. It is a small blue plum, but so far only noted for its early ripening, having produced but scanty fruit as yet. A small blue variety, named Reine Claude Rouge, is worthy of mention, being exceedingly rich, and deserving a place in the family orchard, at least, if indeed it would not be a paying plum for the market. It has the peculiarity of being at its best just a little before it is fully ripe.

CONCLUSIONS.—The results obtained here justify the conclusion that a fair quality of nearly all the commonly planted orchard fruits can be produced in this locality, especially of pears, apricots, plums, and cherries; while apples, chiefly owing to the soil, are less adapted to this locality; and the peaches and nectarines still less so, although if we confine ourselves to a few varieties, the peach can be grown to advantage. It can doubtless be taken for granted, that whatever favorable results have been obtained here in the disadvantageous location occupied by our orchards, can be materially improved upon by proper selection of soil almost anywhere in the coast range.

PEARS OF SPECIAL PROMISE LITTLE KNOWN IN THE STATE.

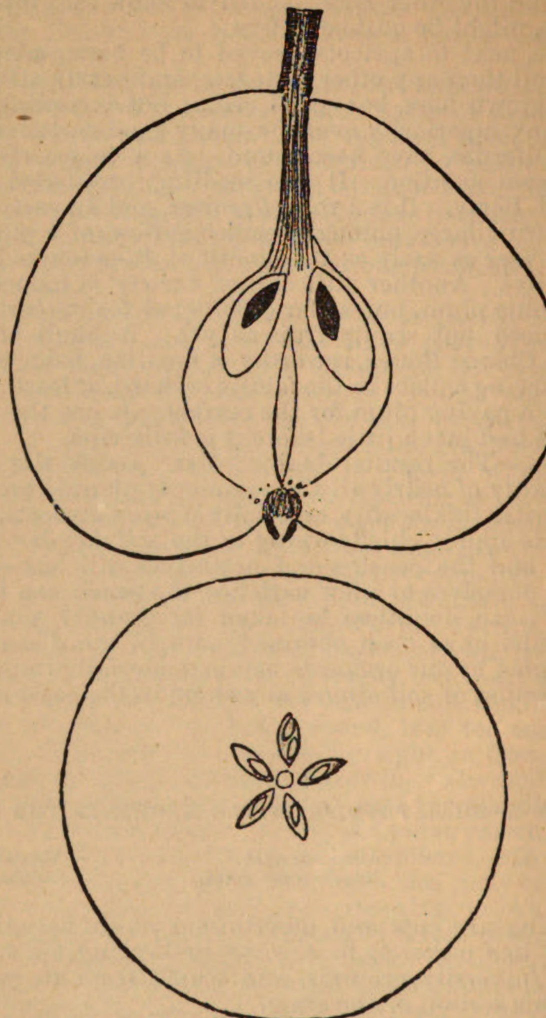
Souvenir du Congrès.	Anne Augereau.	Brockworth Park.
André Desportes.	Napoleon the Third.	Calabasse Monstreuse.

The following are cuts and descriptions of six varieties of pears, which I have had occasion to observe in bearing for two seasons, here at the University grounds, and which seem to be of special promise for this section of the State.

The cuts represent longitudinal and horizontal sections of the fruits in natural size.

We are indebted to the Pacific Rural Press for the engravings, which were made from the original drawings by me in the Orchard Record Book. The manner of producing these was simply by tracing the outline of the fruit cut in sections, and drawing the interior from nature. The descriptions were made at the same time as the cuts in the record book, and furnished by me to the Rural Press, in which paper they appeared during the months of November and December, 1882. On the whole, there are on record in a similar manner, in the orchard book of this department, forty varieties of pears, some of which, perhaps, are equally as promising as those mentioned below, but which I have had no opportunity to observe more than one year.

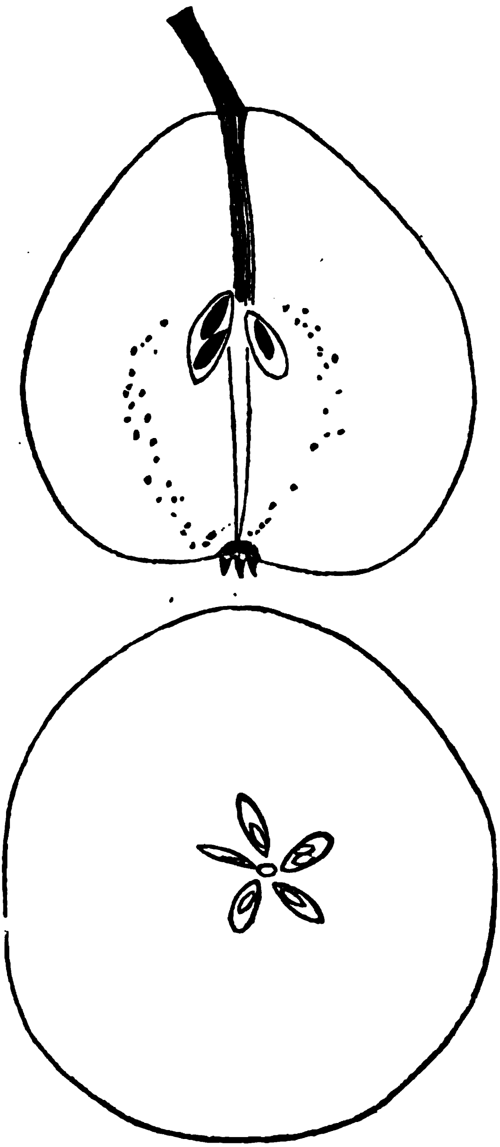
THE PEAR ANDRE DESPORTES.



Tree of fair growth, but of rather irregular, somew
habit. Specimen of fruit of average size and form, wl
date. Skin thick and rough; ground color a yellowish g
with russet and dark green and black dots. Stem very
and fleshy, with hardly any cavity at its base. Calyx op
erect; basin large and regular, with the strong ridges o
minating around it. Core large; seeds perfect. Flesh v
ingly fine grained, melting, juicy, with the peculiar
Bartlett (but finer, compared with the Bartlett producec
orchard). A good bearer and a remarkably good ke
kept sometimes for more than a month in ripe condit
the thirty-first of August, eighteen hundred and eight
ripe the twenty-second of September. Picked in the m

tember, eighteen hundred and eighty-two, it ripened in the course of three weeks, some specimens keeping as late as the thirtieth of November. Owing to its remarkably fine keeping qualities for an early Fall pear, it recommends itself for shipping. According to Downing, this pear originated with Andre Leray, in eighteen hundred and fifty-four. The description found in Downing's Fruit Trees of North America does not quite correspond with the specimen grown here.

THE PEAR ANNE AUGEREAU.



Tree of very moderate growth, but of good habit. Specimen of fruit shown is average size and form, which is broadly oval. Skin thin, ground color yellow, dotted with smaller and larger specks of russet; sunny side with a bright red cheek. Stem rather thin, about one fifth the length of the fruit, inserted in an extremely shallow cavity. Calyx open, sepals distinct, basin shallow. Core large, seeds well developed, flesh firm, white fine grained, somewhat gritty around the core; juicy, with pleasant sub-acid flavor. Ripens in Berkeley about two weeks previous to the Bartlett. Being early and a fine looking fruit, of good flavor, it seems worth recommending for more extensive trial.

SECTIONS OF SOUVENIR DU CONGRES PEAR, AS GROWN ON THE UNIVERSITY GROUNDS AT BERKELEY.

Fig. 1.

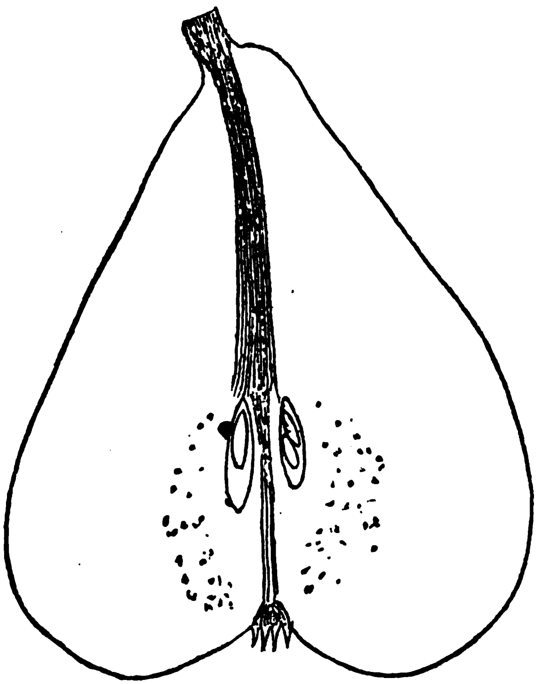


Fig. 2.

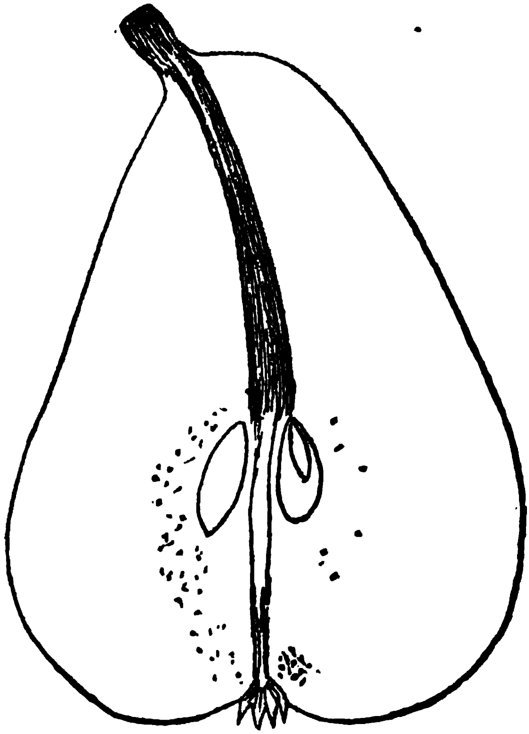
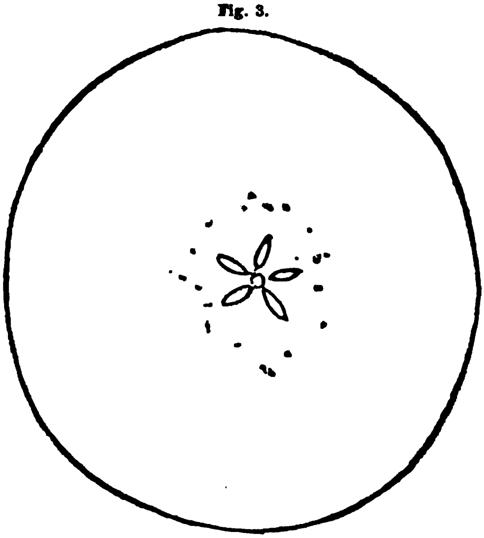


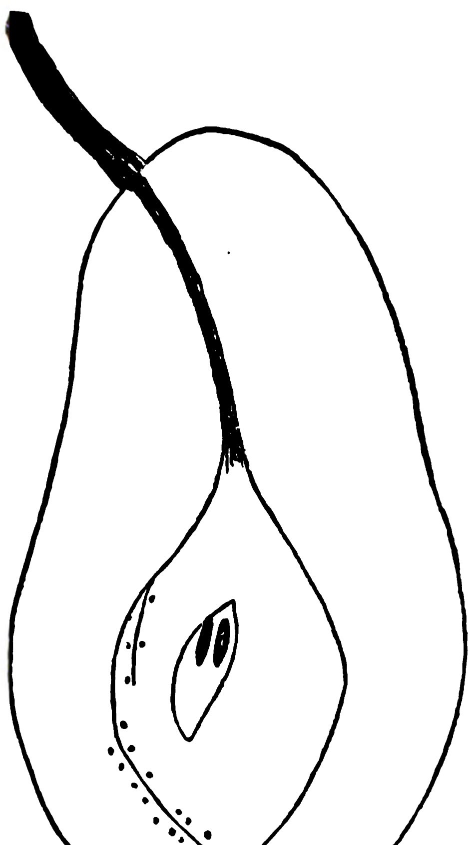
Fig. 3.

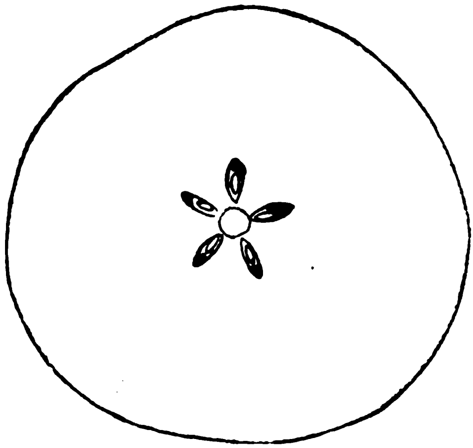


Tree of vigorous and regular growth and upright habit, resembling the Bartlett considerably, but setting fruit spurs more evenly all over the tree; young wood light brown. Specimen of average size,

No. 2; the most common form, though No. 1, is met with quite frequently, and even a still broader form. The shape may therefore be said to vary from obovate to ovate pyriform. Stem short and stout, fleshy, one-sided, inserted without any depression. Skin, when ripe, yellow, vividly flashed with crimson on the sunny side, smooth and rather thin; calyx open; the base well formed and distinct, pointing downward; basin medium; core medium; seeds perfect; flesh white, very fine-grained, rich, melting, juicy, and with some of the Bartlett flavor, but much less musky; a good bearer, but to obtain large size requires extra good thinning out. For an early pear, a good keeper; ripens here a few days or a week earlier than the Bartlett; picked August fifteenth, eighteen hundred and eighty-two, it was ripe the first of September. The above figure differs materially from that given of the same pear in Ellwanger & Barry's catalogue, which greatly resembles the *Calabasse Monstreuse*, figured below from specimens grown on the University grounds.

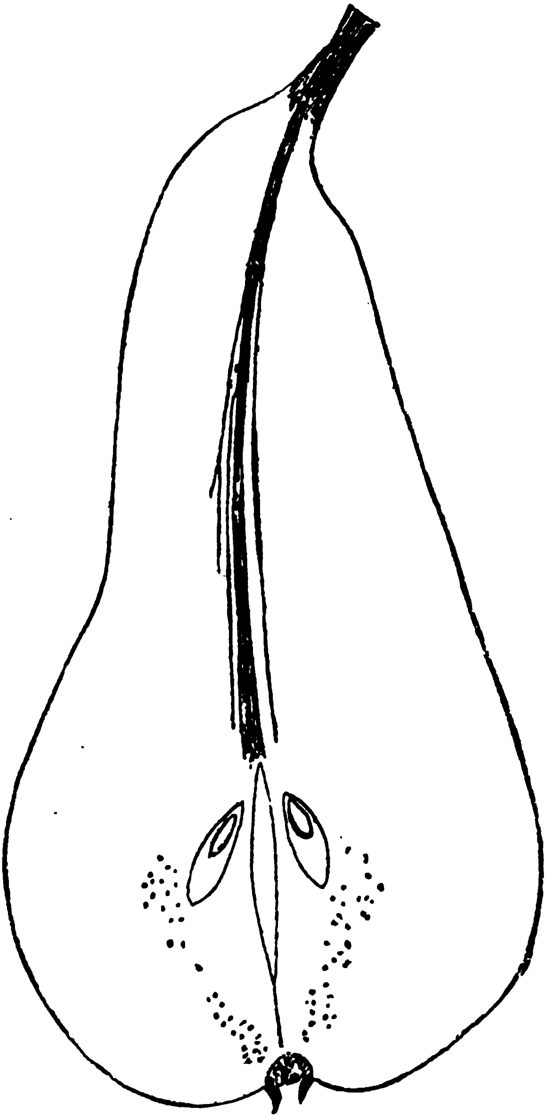
BROCKWORTH PARK; OR, BONNE D'EZEE.

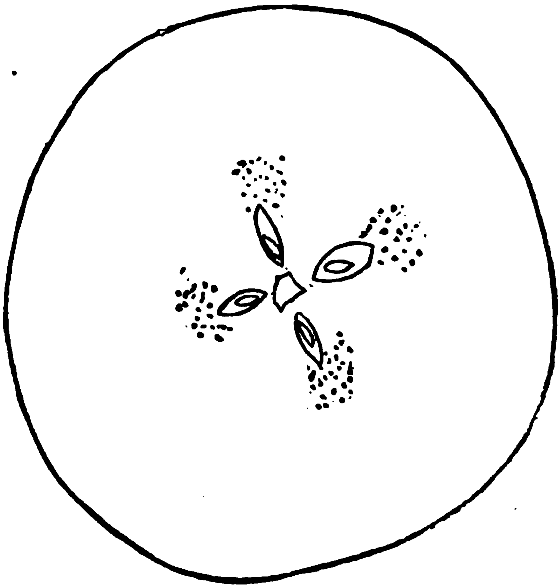




Brockworth Park or Bonne d'Ezee.—This pear, whatever its origin may be, must to all intents and purposes be considered the same as the old Bonne d'Ezee. The growth of the tree, time of ripening, form and flower, are identical. Our reasons for producing this cut and description are twofold. First, to enable those who are familiar with the Bonne d'Ezee to convince themselves of the identity of the two; secondly, to call the attention of those who are not aware of the good qualities of the fruit. The tree is of compact habit; quite vigorous; specimen of fruit of average size; form varying from oblong to ovate pyriform; stem variable from short to one half of the length of the fruit, generally inserted on the side—sometimes right on the summit. Skin rather thick; color, when ripe, a greenish yellow, more or less patched with russet and often with a bright cheek on the sunny side. Calyx open; lobes distinct; basin shallow; flesh dull white, melting sweet, very juicy, with a sub-acid flavor (resembling *beurré gris*); rather coarse grained, a little gritty at the core and calyx. This pear ripens earlier than the Bartlett, a little after Anne Augereau, and keeps for fully one month after picking. Being a good bearer, this plant is entitled to a place in the family orchard, and would doubtless be a pear worth adding to our early market fruits.

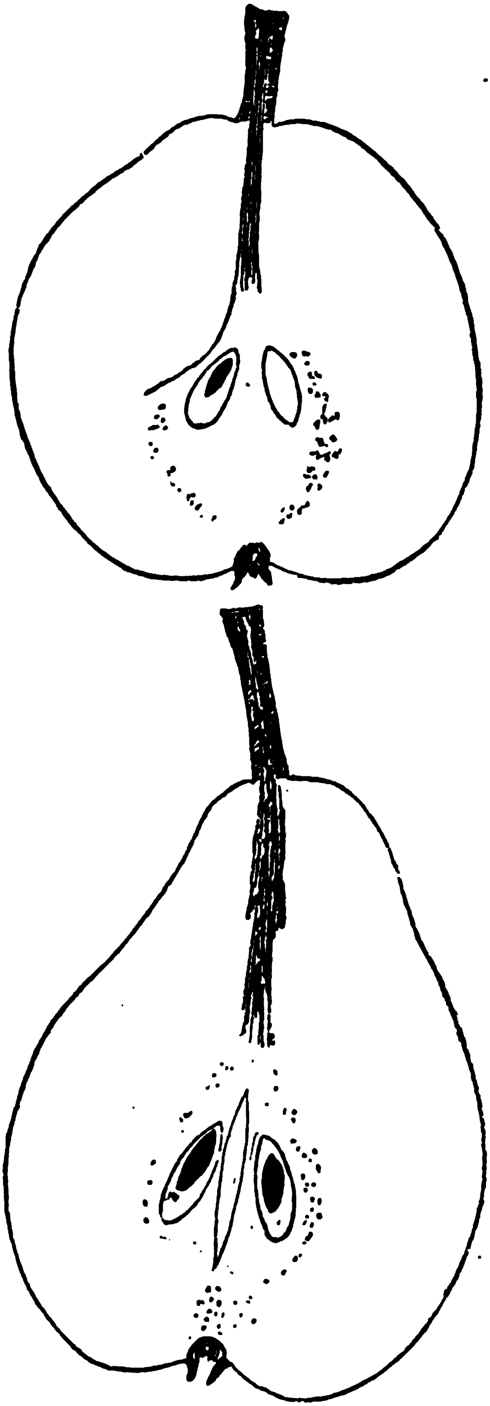
CALABASSE MONSTREUSE.

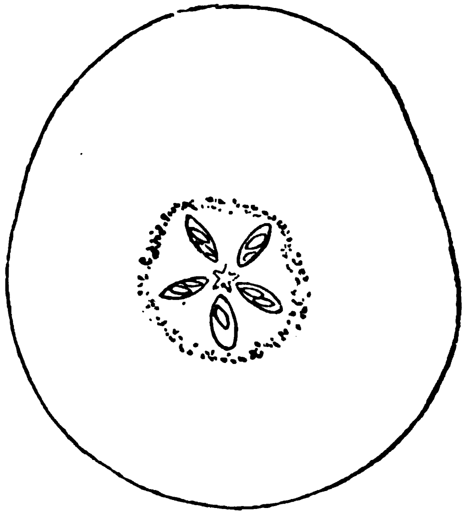




Calabasse Monstreuse.—Tree of compact growth, coming early into bearing; specimen of average size, often much larger; form oblong, sometimes almost club shaped and curved. Stem short and stout, passing gradually into the long neck. Skin thick, completely covered with russet, sun side often very red; calyx green; lobes distinct, core medium; seed vessels often only four in number, seeds perfect. The flesh very firm, but when thoroughly ripe juicy and of a fair flavor. It is a first class cooking pear. Picked at the end of August, it becomes fit for cooking in a couple of weeks, one or two weeks more making it perfectly ripe. Being produced in abundance and regularly every year, this handsome large pear ought to be a desirable market fruit. The specimen grown here differs considerably from the fruit described by Downing under the name of Van Marum.

THE PEAR NAPOLEON THE THIRD.





The tree is a vigorous grower, and of good habit, the fruit spurs often armed with stiff, sharp thorns. The fruit varies in form, as the two specimens shown in the cuts, from ovate to almost round, often compressed sideways. The stem is rather short and stout, inserted squarely at the base of the fruit. The skin is thick. The ground color is a dull yellow, covered more or less with patches of russet; occasionally with a bright cheek on the sunny side. The calyx is open, its lobe pointing straight downward; basin medium. The core is rather large, seeds well developed—large. The flesh is white, fine-grained, somewhat gritty around the core, buttery, sweet, juicy, slightly viscus. A good Napoleon the Third ripens in Berkeley at the beginning of January, and keeps well. No doubt it can with care be kept to March. Being an early and abundant bearer, and a pear well adapted for shipping, it seems worth recommending to the fruit grower.

VINEYARD.

The small vineyard at the experimental grounds was found last year to be infested with the phylloxera. Being of very small size and situated in a locality little favorable for grape growing, but containing a large number of varieties of European and also of some American grapes, this discovery was not altogether unwelcome, inasmuch as it opened a new field for the study of the insect, and for experiment with remedies for its destruction, in a region remote from any vineyards. Whatever new observations have been made in regard to the insect itself will be discussed by Mr. Morse, and I shall confine myself to a few facts concerning the resistance of the various vines.

All the European (*vinifera*) varieties, about sixty, are showing signs of the disease, though some vigorous kinds, as the Rose of Peru, and others have, even during last summer, made a remarkably fine growth, and produced fine bunches of grapes which however owing to our cool climate, have not ripened yet (end of October). Next in showing the effects, come what naturally should be supposed the

hybrids of *vinifera*, Cornucopia and Canada (hybrid between Clinton and West's St. Peters). The roots of these are very badly infested, and show a rapid decline, more so even than a few pure *vinifera* adjoining them. The American grapes, Walter, Martha, Othello, Herman, and a few others, though badly infested, are still quite vigorous; especially does the Diana—close to dying *viniferas*—hold its ground remarkably well. The collection was this year increased by some of the best American varieties, donated by Mr. Geo. Husmann, of Napa, but of course no conclusions as regards their resistance could be expected yet, especially as they were planted on ground not previously occupied with grapes. Beside this, the dead *viniferas* were this spring replaced by others, grafted the previous year on the roots of seedlings of *Vitis Californica*. Set in among the infested vines, they present now a remarkably fine appearance, contrasting their deep green color to the fading foliage of the latter. Having all been purposely infested with the root-louse, we hope the coming year to get some valuable conclusions from them. In addition to these a row of seedlings of the *Vitis Arizonica* have been planted next to the infested vines.

It deserves mention, that the vineyard is planted on a rocky, very heavy loam, underlaid by a heavy, impervious clay subsoil—only drained by a road-cut made through the lower part of the slope on which it lies. The vines have never been irrigated, and the soil becomes, at the end of the season, so extremely hard and dry that it cannot be dug into save by means of a pick.

The great importance of finding a cheap, durable grafting stock adapted to the *Vitis vinifera*, and resistant to the phylloxera, has, for many years, agitated the grape growers of Europe, and lately, also, the more thoughtful and far-seeing viticulturists of California. In France, the country to which we naturally have gone for our information in this direction, because of its comparatively long experience, and of the careful and painstaking experiments, all the American wild grapes east of the Rocky Mountains and a multitude of their varieties have been tried for years. According to their adaptation to soils they have been grouped together and their behavior noted, and, as every one knows who has taken the pains to read the works of Professors Foex and Millardet (translated for the Report of the Viticultural Commission), some most valuable material has been collected. But while all the Eastern varieties have been known and tested for many years, the two species *Vitis Californica* and *V. Arizonica*, of the Pacific Coast, have only been tried in France for about two years. Since you at Sonoma, six years ago, for the first time called public attention to the probable adaptability of *Vitis Californica* as a suitable grafting stock, much has been done to arrive at definite conclusions in this respect. Large quantities of seed have been gathered, and by Mr. Wetmore, of the Viticultural Commission, sent to France. Mr. Wetmore himself has grown this species, as well as the *Vitis Arizonica*, on a large scale, and in his official capacity disseminated considerable information about both. As regards the definite proofs for the resistance of the *Vitis Californica* to the phylloxera, I shall prefer to defer judgment on the question for another season, though from more than one source I have heard of cases that tend to prove it almost beyond doubt. I will only give our experience here concerning its propagation from seeds, its growth, and adaptation as a grafting stock for *vinifera*.

We have for three years in succession grown the *Vitis Californica* from seeds, with more or less success, in the open ground, and found the end of March or beginning of April to be the best time for sowing of them in this locality. If planted much earlier they will generally not germinate; and when, owing to unusually mild weather, they do appear above the ground, late spring frosts are apt to nip them. The depth of planting should not be much more than an inch—one half to three fourths of an inch being the average of the seeds sown here. The quickest germination I have observed was with seeds soaked for a week in water, and left heaped together for three weeks; the majority of which started in two weeks or ten days after being put in the ground. In a well prepared bed, deeply worked and made comparatively porous by admixture of rotten horse manure and lime with the naturally rather heavy loam, we have raised plants of which thirty to forty per cent could be made available for grafting *the first year;* better results than this even, can doubtless be obtained where the soil and climate are more favorable. The stocks used here for grafting averaged about one third of an inch in diameter, and fifty per cent of such, with care and by thinning of the plants when young, can be produced in naturally moist bottom land; as, for instance, that of Mr. Wetmore's nursery, at Pleasanton, Alameda County. There, without a particle of irrigation, almost that result was obtained, although the plants were not thinned enough. *Vitis Californica* has one weakness that in the coast climate may be somewhat of an objection, namely, being rather subject to mildew, even more so than the (European) varieties of *vinifera*, and much more so than the *riparia*. Sulphur will, however, remedy this evil, as well as in the case of *vinifera.* This weakness can be no serious drawback for its utilization, inasmuch as it does not influence the graft; grafted *viniferas*, being on the contrary, as it seems, less subject to mildew than when on their own roots. In localities therefore where mildew is to be much feared, and the *Vitis Californica* is desired for a grafting stock, the sooner the grafting is done the better the result will be.

We have not grown cuttings of the *V. Californica* to any great extent, but find that they root with difficulty—a conclusion that has been confirmed by others. Once rooted, however, they very soon become strong plants, and the root system, although never equaling that of the seedling, is equal, if not superior, to that of the *riparia*. The feeding roots of the *Vitis Californica* have a decided tendency to go down with the main roots (a good illustration of which can be seen in the report of the Viticultural Commission of 1880), and in this proves its true Californian character and adaptation to climate, seeking as it seems, the moisture. Judging from this nature of the root we must also conclude that it is only adapted for soils of considerable depth, and that on shallow soils it will not prosper. Its occurrence along our river banks seems at first to indicate that abundance of moisture is necessary for its proper development; but when taking into consideration that the seeds which we know require a great deal of moisture for germination only would find this in such places, we have a sufficient explanation in this fact alone. The dissatisfaction with the *Vitis Californica*, and complaint that it made very little growth, I believe is due to its being planted either on shallow soil, where it never will be suited, or on soil where the moisture sinks in summer to a greater depth than its roots would reach the first

year. This seems to be the case in the Santa Cruz Mountains, where I have personally tried them on a sandy loam; here the moisture is plentiful, but it is during mid-summer at considerable depth, and fruit trees even, if not planted in very deeply worked holes, do not make much growth the first year, while their growth in the second, in proportion, is astonishing.

In Livermore Valley we have seen the *Vitis Californica* alongside the *riparia* in a variety of soils, heavy as well as gravelly, and it seems here at least to be equal, if not superior in growth, to the latter. On much of this land wheat, in a year like the last, would be a complete failure, owing to want of rain. All these soils, although quite different, are of considerable depth.

It is perhaps outside the scope of this report to enter into the particular requirements of the *Vitis Californica*, but being convinced by actual experience of its adaptation to the *Vitis vinifera* as a grafting stalk, we have been impressed by its importance, and aim at studying this question in all its bearings.

GRAFTING.—The mode of grafting adopted here, in our experiments, has been the English cleft graft, or perhaps better known as the whip graft. The chief reason for this particular graft being preferred was its adaptations for stock of small diameter, nearly all our available stocks being such—and we have used it for two seasons with comparative success. (For illustration of this graft see the report of the Board of Viticultural Commissioners for 1881.)

I am confident that the favor it has won in France is due to its many advantages. It facilitates a firm and thorough union, and being adapted for the workshop presents the advantage of carrying on the work when it would be out of the question to graft outdoors, and the comparatively greater perfection of the work performed in the workshop makes it superior to the average grafting in the field. As regards it not being possible to perform the operation as quickly as the common split graft in the field, this objection will only apply where the work is all done by hand and knife instead of special machines adapted for this purpose, as is done in France. The cost there does not exceed fifteen francs, or three dollars per thousand, when done on a large scale. If, allowing for the great difference of labor prices in California, we triple this amount, making it nine dollars per thousand, yet only a very reasonable price is reached. That this mode of grafting, in all cases, is the preferable one, I by no means pretend; but that it in certain cases becomes the most practical, I am satisfied, and it is always entitled to great consideration where small stocks must be grafted.

The treatment of the stocks and circumstances attending the grafting during the two years, 1881 and 1882, has been a little different each year, the first year's experience suggesting some improvements, which were carried out the second, and also the difference of the two seasons marking the grafting-time unlike. Both years the seedlings were taken up during December and heeled in until grafting-time, when they were dipped in a paste of cowdung and soil before being removed to the grafting table—this being done to preserve the finer roots from drying during the operation. The grafting was, in 1881, performed the fourteenth and fifteenth of February, while it was done more than a month later—the seventeenth and eighteenth of March—this year—1882. The vines were, in 1881, already planted the eleventh day of March, therefore even earlier than the grafting was done the present year.

ne small size of the stocks both years (one year old seed-
tilized), the graft was made very low, right in the root-
lanting, however, they were set with the union above
ough this was temporarily covered. The material for
fia, a fine bast-like fiber, while the precaution of using
as well as wrapping of a strip of cotton outside of this,
n.

peration had been performed, the plants were removed
ce; but while in 1881 they were only partially buried,
d of the graft being left above ground, this year they
covered. Whether owing to this, or to the fact that it
days later (the thirtieth of March) when they were
buds on the grafts were swelled better this year than
nting, of course, great care was taken in handling the
and they were set just deep enough to leave the union
d when the hill of soil which temporarily was raised
graft should be removed.

planted in the bed, the treatment was substantially the
ears, with this difference only, that instead of waiting
ns were over, or about a month, before putting a mulch
this was done a few days afterwards this year, while
sprinkled a few times more.

the young shoots from the graft showed a stoppage in
the soil around them was removed completely. It was,
nd necessary to go over all the vines, to rub off the
d sprung from the grafts. When these had become
that the life of the graft would be endangered by doing
nd to be a good practice only to uncover them, thereby
to dry up gradually, the vine thus absorbing part of the
contained in them. In consequence thereof, no graft
ted was lost. By the first of July, nearly all that were
rted, although a few weak ones appeared as late as the
nber. At the end of August, the union of the grafts with
sufficiently strong to allow the complete removal of the
hem, and they were then all staked and tied firmly, so
ld be no danger of the grafts breaking off by the wind.
nce in number of variety, their condition, and so forth,
e value of the experiments of both years better under-
n separately, and we shall therefore first give that of

ng tables show the number of grafts made, and the num-
iving. The scions were from three distinct localities:
iversity grounds, which were of a rather pithy nature;
nzel's Alhambra ranch, Martinez, Contra Costa County,
ather of a medium firmness; and from the Eisen Vine-
of very ripe wood, but perhaps rather dry.

Grafts from Alhambra Vineyard, Martinez, 1881.

Grafts Partly or All Living.	Number of Grafts Made.	Number of Grafts Living.	Grafts Having Totally Failed.	Number of Grafts Made.
Black Hamburg	3	1	Seedless Sultana	6
Muscatel	5	1	Flaming Tokay	2
Mission	3	3	Black Corinth	6
White Madeira	5	4		
White Malvoisie	5	2		
White Corinth	3	1		
Chasselas Rose	2	1		
Purple Constantine	3	2		
Totals	29	15	Total	14

Grafts from Vines on University Grounds, 1881.

Grafts Partly or All Living.	Number of Grafts Made.	Number of Grafts Taken.	Grafts Having Totally Failed.	Number of Grafts Made.
Black St. Peter	6	5	Early Smyrna Frontignan	5
Bowker	3	3	Early Black Bourdon	3
White Tokay	3	1	Lady Down's Seedling	5
Madelaine Royal	3	1	Champion Hamburg	3
Mill Hill Hamburg	3	3	Barbarossa	3
Muscat Hamburg	3	1	White Nice	4
Rose of Peru	3	3	Purple Damask	3
Golden Hamburg	3	1	Childs' Superb	3
Foster's White	3	1	Trebbiano	3
Syrian	3	1	Canon Hall Muscat	3
Reine de Nice	3	1	Royal Muscadine	3
Victoria Hamburg	3	1	Golden Chasselas	3
Deacon's Superb	3	1	Black Lombardy	1
			Black Morocco	3
			Cornucopia	3
			Muscat d'Août	3
			Wilmot Black Hamburg	3
			Duchess of Buccleuch	3
			Newton's Guest	3
			Early Silver Frontignan	3
Totals	42	23	Total	60

Grafts from Eisen Vineyard, Fresno, 1881.

Grafts Partly or All Living.	Number of Grafts Made.	Number of Grafts Living.	Grafts Having Totally Failed.	Number of Grafts Made.
Pedro Jimenes	5	1	Pinot Noir	5
Gamay de Gamay	5	1	La Folle Blanche	5
Malbeck	5	1	Jurançon	6
Black Ferrara	2	1	Charbonneau	5
Sauvignon	5	2	Yellow Orleans	3
Chile Rose	5	1	Merlot	5
Mataro	5	3	Fiherzagos	5
Verdal	5	1	Miccordel	6
Chablis	5	2	Verdelho	5
Chignanne	5	3	Gamay	5
Miller's Burgundy	3	2	Malvoisie de Puy de Dome	5
Black's Grenache	5	4	Zinfandel	5
Marseilles	5	2		
Kakauer Blanc	5	2		
Jeres	5	1		
Totals	70	26	Total	60

Comparing the proportion of the successful grafts from each locality, we have a little more than half of those varieties that grew at all, for those from Berkeley and Martinez, and somewhat more than one third for Fresno; while, if we compare the sums of the whole number of those grafted from the three localities, we have a little more than one third for Martinez; Berkeley, less than one fourth, and Fresno about one fifth.

That the condition of the grafts had a good deal to do with the failure is quite certain; the Berkeley grafts, on the whole, being too pithy, and the wood of the Martinez grafts corresponding more in ripeness with the stock, while the Fresno kinds were rather too firm, and a little dry besides. Still, the results seem to justify the conclusion that there is considerable difference in the ease with which the union of the different varieties is effected; for the taking of 100 per cent or 80 per cent of some against none of a great many varieties, not of the one group alone, but of all three, is too decided to be dismissed as accidental or due to the condition of the graft.

The following table of the grafts made, and of the numbers taken, is of the present year's (1882) experiment. Beside the *Vitis Californica*, there are a few grafts made on the *Vitis Arizonica*, *Jaquez*, and *riparia;* all of which, however, were in an unfavorable condition, having been badly frosted, and for the sake of comparison with 1881, we have put these in a separate column:

Grafts made on Seedlings of Vitis Californica, 1882.

I—From the University Grounds.	Number of Grafts Made.	Number of Grafts Living.	II—From the Simonton Vineyard, Napa County.	Number of Grafts Made.	Number of Grafts Living.
a—Partly or all living.			Chasselas folle	16	10
Mataro	10	8	Mataro	12	7
Black St. Peter	10	10	Black Burgundy	10	2
Rose of Peru	10	9	Queen Victoria	15	10
Canon Hall Muscat	10	8	Chass. Fontainebleau	12	7
White Madeira	10	10	Seedless Sultana	17	16
Barbarossa	10	9	Sauvignon Vert	9	6
White Nice	10	9	Chass. Rose	15	9
Marseillaise	10	2	Franken Riesling	15	2
			Zinfandel	10	6
Totals	80	65	German Muscatel	15	6
b—All failed.			Black Malvoisie	15	12
Early Malingre	5				
Miller's Burgundy	5				
Totals	10				
Grand total	90	65	Totals	161	83

III—Grafts made on Seedlngs of Vitis Arizonica, Jaquez (Æstivalis), and V. Riparia.

	Number of Grafts Made.	Number of Grafts Living.
Mataro (on Riparia)	3	2
Black St. Peter (on Arizonica)	10	5
Black Burgundy (Arizonica)	10	2
Black Burgundy (Riparia)	6	1
Sauviguon Vert (Jaquez)	6	2
Zinfandel	5	3
Totals	40	15

As a glance at this table shows, the results obtained from this year's grafting were infinitely better *in toto* than those of last year, and as regards the Berkeley grafts, would have been still better if Marseillaise, Miller's Burgundy, and Early Malingre had been left out, the failure of which must be sought in the small size of the grafts. The cause for such superior results, compared with 1881, may lie in several circumstances. In the first place, in a more careful selection of the quality of grafts; secondly, in a more favorable treatment after the grafting was done, by burying the whole vine, causing the grafts to re-absorb the moisture they had lost since the separation from the parent vine; thirdly, the greater care exercised in keeping the soil moist around each graft until started.

The difference in the percentage of those from the University grounds, there being more than three fourths to only about one half to those from Napa, seems to point to some difference in the quality of the grafts, making them less inclined to form a union than grafts of vines grown here. That it was due to the considerable loss of sap resulting from shipment, is not likely, as this loss after the burying in the ground seemed to be compensated, the buds presenting as fine an appearance as the grafts taken from the vines here. Be this as it may, there seems again to be evidence that there is considerable difference in regard to the facility of the union of the different varieties. (Compare those from the same section with each other.) It will also be seen, that the same varieties grafted in 1881,* show with some exceptions, almost the same percentage. Without considering these details, which interesting as they are, can only be definitely ascertained by a series of careful experiments in the same locality and under the same conditions, it must be considered definitely proved that the *Vitis Californica* is well adapted as a grafting stock for a large number of the varieties of *Vitis vinifera*. The union formed is very perfect, and vines in the second year from graft, present a most perfect appearance at the root crown, it being in some cases absolutely impossible to discover that the vine is not growing on its own root.

As regards the other stocks mentioned, they can hardly be entitled to much consideration, since they, as stated, were somewhat frostbitten; that a number of them nevertheless grew, shows their adaptation. With regard to the *Jaquez* (Lenoir) and *riparia*, this, of course, has been known for years in France, and with the Lenoir,† we are glad to note the case of Mr. J. R. Wolfskill, at Winters, Solano County, who has several hundred Muscats growing on this root, on which they were grafted a number of years ago with the loss of only a small percentage. The *Vitis Arizonica* presents one advantage over all the other stocks, namely, that of the stem being undivided for four to six inches above ground, affording thereby a greater facility for grafting. As a number of these are growing at various places in the State, we shall, no doubt, soon know more of this quality, which seems very promising.

GARDEN OF ECONOMIC PLANTS.

The garden set apart especially for economic plants, has beside those mentioned above been devoted to the culture of a large variety of plants, the majority of which, however, have been on too small a scale to be of much more use than to establish the fact that they

* Those on the list marked with an asterisk (*).

† Mr. J. R. Wolfskill received these vines from Alabama, under the name of Coon grape; it is, however, according to all evidence, identical with the Lenoir or Jaquez.

could be grown in this climate, and also, to aid demonstration in the courses of practical agriculture and botany. The various forage plants, including grasses and certain root crops, grown on a somewhat larger scale, will be discussed by Mr. Dwinelle. The number of medicinal plants has been slightly increased, but not to the extent hoped. Seeds of these plants can only be obtained from botanical gardens by means of exchange; unfortunately here again we have been obliged to let pass more than one opportunity, for want of funds. For the same reason, the space otherwise intended for annual plants has been left unoccupied last year, on account of the expense attending the proper care of these plots.

NURSERY.

In the tree nursery, we have had during the last two years a large increase of eastern, foreign, and native trees and shrubs, some of which, notably a collection of about twenty species of oaks, have found permanent place on the University campus, outside of the agricultural grounds proper. Of the various trees mentioned in the last reports of this Department, we can only confirm the opinion then passed upon them. The collection has chiefly been made with a view to getting many distinct species of plants, rather than a great number of each, always bearing in mind that the University grounds ought, in the near future, to become the site of a botanical garden. Apart from this, however, any tree that has been deemed of especial value and not procurable in the nurseries, has been propagated as much as possible. A list of these will be found below. The trees and plants distributed during 1881 and 1882 numbered about five hundred and fifty, and two thousand two hundred and forty-three seedling vines of *Vitis Californica* sent to about seventy-five different parties all over the State.

GREENHOUSES AND PROPAGATING GROUNDS.

The collection under glass has during the last two years been increased very considerably—almost wholly by means of seeds and exchange; very few plants having been bought. It contains, besides a number of plants that we cannot depend upon as being hardy in our climate here (as Carica Papaya, *Arrona Chirimoya*, etc.), a collection of tropical plants of economic value, as Coffee, Banana, Vanilla, Tamarind, Annato, Silk Cotton Tree, and others of less importance. Cramped for room and suffering from cold in the winter, owing to a defective cheap heating apparatus, only intended for temporary use, the plants are unfortunately not seen to any advantage, and suggest perhaps more than anything else the necessity for better accommodations in this direction. Under the same roof, and in the same apartment, we are forced to house during the winter plants from the most different climates, demanding different atmospheric conditions; in consequence of which none can be altogether suited. As the houses are during the early spring filled to their utmost capacity (many plants touching the sashes above and growing beyond the pots that can be given them), we shall necessarily have to abandon some of our collection, if no better accommodations can be procured; and thus the patient work of gathering a collection of such plants, many of which cannot be obtained in the nurseries, will

to that extent have been lost. On the whole, the additions of plants, useful as well as ornamental, amount to about five hundred distinct species—not counting in the large number of different cereals, of which about two hundred varieties have been cultivated since the garden of economic plants was established. All these, as stated before, have been gotten almost solely by means of seed and exchange at a comparatively small cost; and the increase could easily have been much larger if our accommodations were better, so as to afford encouragement in this direction.

EXOTIC FRUIT TREES AND SHRUBS.

The Japanese species of chestnut distributed extensively by the San Francisco Bulletin Company, and also introduced by others, is a tree of less robust habit than the European or Italian, and its bushy growth and tendency to sucker, make it better adapted for a hedge than for a standard tree; this is, also, we understand, the manner it is generally grown in Japan. It is not nearly as fast-growing as the Italian, but is said in Japan to bear in five years from the seed. It appears that in Japan there are a number of varieties of chestnuts propagated by grafts, and of unusually large size—a tree of one of these has been procured for the grounds here.

Of the *Macadamia ternifolia* (Queensland Nut Tree), also mentioned in the last report, little can be said except that it seems perfectly hardy but is of extremely slow growth.

The Edible Barberry (*Berberis heteropoda*), has proved itself well adapted to our climate here, though of very moderate growth. This barberry, which is a native of Turkestan, has the reputation of being the best of its kind, but fruit has not, to our knowledge, been produced in this State as yet. Plants sent to Los Angeles are reported as doing well.

The *Diospyros Lotus*, or so-called Italian Persimmon, does exceedingly well here. It is quite an ornamental tree, marked by foliage of a dark bluish green of a peculiar luster. It has never suffered from frost, but owing to its habit of growing late in the season, it is not to be depended upon in localities where early and rather severe frosts occur. As a grafting stock for the Japanese persimmon, it has an advantage over the American, on account of a far better root system.

The Aguacate or Alligator Pear (*Persea gratissima*) has now for three years withstood the Winter frosts in a sheltered position, and proves, perhaps, more strikingly than anything else grown here, how little we can foretell what will prove hardy.

The Date Palm.—Before leaving the fruit-bearing trees, I cannot refrain from speaking a few words in favor of this most widely useful of all fruit trees. As this locality, owing to its close proximity to the sea and cool summer, of course never can be expected to ripen dates, we are naturally debarred from making any experiment in this direction, and must content ourselves with seeing the foliage of this elegant palm. But there exist in California many localities where dates would ripen, and undoubtedly would prove a great acquisition. This fruit has ripened more than one year at Mr. J. R. Wolfskill's place, on Putah Creek, near Winters, Solano County, on a tree raised from seed, bearing about as early as in Egypt and Algeria. The few date palms grown outside of this region have been in localities too near the sea, or rather, with too cool a summer tem-

perature, where, according to all accounts, they never have ripened. When we consider that the propagation of the varieties of date palms developed during its long culture, is chiefly carried on by means of the sprouts, the seeds being used only in the most favorable localities, the case of ripened dates in as high a latitude as 38° N. is of great significance. It proves the importance of one of the factors for successful date-growing possessed by Californian climate, viz., a long, dry, rainless season. The regions that, by precedence, ought to be and undoubtedly will become a flourishing date country, is the southern part of the great San Joaquin plains, wherever water of some kind can be procured.

Frost not exceeding 18° will not hurt good sized trees, provided it falls inside the time from November to March—that is, outside the period of flowering and fruit ripening; nor will the hot winds of the worst kinds hurt this palm, the home of which is the desert, and to the condition of which its nature seems to be perfectly adapted.

The date palm, when supplied with even alkali water, will thrive in a climate too hot for any other fruit tree known, giving shade to plants that otherwise would suffer from the heat. To obtain varieties suitable for our climate, we cannot rely upon raising them from seeds; but the kinds maturing in the northern date zone, adapted to a climate like that of southern interior California, must be procured as cuttings or rooted plants. This of course requires considerable capital and is a scheme worthy of government aid.

I find that in the year of 1860 the Agricultural Department at Washington imported some date sprouts and seeds from Palestine, but how much of a success they were I have not learned. As Palestine is not a true date country, that palm there being more of an ornamental tree, it is not likely that any good fruiting varieties were obtained. In the same report (U. S. Agricultural Report for 1860) we find an article by Geo. Atwood, in which it is mentioned that the date palm is flourishing with the *Carica Papaya* at St. Augustine, Florida. If it really is much of a success there, it is strange that it has not been mentioned since, and if St. Augustine is a locality adapted for it, the climate must be a good deal different from that of other parts of Florida, where the frequent summer rains would practically exclude date-growing on a large scale.

MISCELLANEOUS USEFUL TREES AND SHRUBS.

In the report of this Department for the year 1880, a full account of the growing of a number of Cinchona trees was given, but only the experience of a few months of winter climate had then been had, leaving it for the future to decide their adaptation to the climate. Unfortunately the means at the disposal of this Department have always been too limited to give the proper conditions to these very peculiar plants. The Cinchona is, at best, a tree very difficult to handle, especially when pot culture has to be resorted to in a large measure. It is a well known fact that for this reason it is seldom met with in collections in botanical gardens in Europe. The history of the introduction of the Cinchonas into India and Java is, in itself, a lesson to us, showing the extreme care and the amount of money expended by the respective governments before any satisfactory results were reached. To draw any but the most general conclu-

sions from our small experiments, cramped by want of proper facilities and means, would be premature; but in spite of our partial failure to prove their adaptation, we still believe that there are localities in the southern part of the State, where the Cinchona could be made to succeed. That there exist very large tracts of land in any particular county is not likely, but that localities do exist, we are confident. It is generally known that there are localities. even in this county, where frost is hardly known, so that tomatoes live from year to year.

From Santa Barbara we have learned of more than one place where the Cherimoya apple has grown for years and borne fruit. As with us, the Cherimoya apple two years in succession has succumbed to the frost, right alongside of *C. Succirubra*, that survived, we think it but reasonable to suppose, that the latter would live in a locality where the former is hardy. Similar instances as that of Santa Barbara have been reported from Los Angeles, and exist probably in all the southern counties.

But to return to our principal drawbacks and difficulties in raising the Cinchona here. First and foremost, there is great difficulty in keeping the plants alive in pots, except when the most thorough system of drainage is adopted. Even then, in many cases, decay and giving-out of the young fibrous roots, causing a sickening-away of the plant inch by inch, took place, the leaves turning yellow, making the plant unable to stand exposure to the sun without getting scorched, and thus resulting in final collapse.

That the character of the water used had a good deal to do with this is evident, and the use of rain water was therefore adopted as much as possible, alleviating the trouble to a certain extent.

We lack, moreover, the proper facilities for their propagation; being obliged to use a house where a multitude of different kinds of tropical plants had to be wintered, and where it was an impossibility to maintain an even temperature, such as is necessary for the successful propagation of the Cinchona. The latter difficulty is really the reason why no large stock could be made. While the raising from the seed is a slow process, cuttings form healthy plants, and strike root with great facility, growing also much faster than seedlings; to obtain these it is, however, necessary to have a well regulated greenhouse, especially adapted for the purpose of growing the so called stock plants; these are strong plants, planted in a well prepared bed, where an even temperature by artificial means is maintained; being partly layered they produce a number of shoots, which being cut again produce a new crop serving for cuttings. Stock plants of Cinchonas must be well rooted, and plants growing in pots cannot be used successfully, since they get exhausted after being cut once; as we have demonstrated here, our attempts in this direction having brought about but a slight increase, many of the old plants dying. The mode of getting cuttings from stock plants planted out in beds is the only practical method for increasing a limited stock, and the one adopted in India itself at the beginning of a plantation; and until we can afford a similar practice, we can but expect very limited success in growing Cinchona.

We shall now briefly give a summary of the results we have obtained, laboring under these disadvantages, since the publication of the last report. It was stated then that three species, *succirubra*, *officinalis*, and *Condaminea*, growing on the experimental grounds,

partially sheltered, received no apparent injury from the frost, while the *Cinchona calisaya* and the hybrid died. In the spring, however, *officinalis* and *Condaminea* were attacked by a peculiar fungoid disease, a little above the ground, spreading in a few days, causing the stems to decay and killing the plants completely. This disease, we have learned, is quite common in the young plantations in India, often making great havoc there.

The only species, therefore, that survived in the open air was the *Succirubra*, which continued to grow remarkably well through the summer, receiving but three waterings. The early rains and preceding moist but mild weather seemed to agree perfectly with its nature, and it continued to grow all winter, and by the time our first severe frost that occurred in the beginning of January, 1882, it stood about four feet high, with a handsome crown. The cold, which probably did not go below 26°, killed it to the ground, and although it again has made a start from the root, the shoot is too tender to withstand any frost. Owing to our supply being so very limited, we have not thought it wise to try any more plants in this locality in outdoor culture. The first distribution was made at the end of April, 1881, when the severe frosts of the season were supposed to have passed. Plants were sent to twelve different persons (who previously had applied for them), living in ten different localities, situated in seven distinct counties, as follows: Fruitvale, Alameda County; Martinez, Contra Costa County; Rohnerville, Humboldt County; College City, Colusa County; Nordhoff, Ventura County; Carpinteria, Santa Barbara County; a location near San Gabriel, Los Angeles County; and Santa Rosa Island, in Santa Barbara Bay, besides a few plants scattered over Oakland and Berkeley. The plants were all carefully packed in boxes, and each plant in a pot, nearly all being shipped by express.

In June, 1882, a letter of inquiry was sent to each person having received Cinchona trees, submitting the following questions:

Character of soil in which planted? Exposure of location? Condition of trees when received? Condition and size now? Amount of irrigation, if any used, and how late in the season applied? If dead, what was the probable cause? If killed by frost, at what time did it occur? If possible, give the exact temperature at which they succumbed, and also the atmospheric condition at the time, whether moist or dry.

Direct or indirect answers have been received from eight of the persons to whom inquiries were sent, some of whom were very careful and painstaking. It appears from these, that in all but two cases the plants arrived in splendid condition; that the soil selected for them was well drained, ranging from a gravelly heavy loam to a lighter soil, rich in humus. In all the northern counties, as also in Ventura County, they grew fairly until the occurrence of frosts, when they were killed to the ground (temperature and atmospheric condition not observed); the only exception to this being the locality back of Fruitvale, where one is still living. In the southern counties, also, all but one died. The fact is attributed to various causes; in one case it is given as being too hot, while in another, at Carpinteria, the failure of two of the plants is not definitely known to be due to frosts. From this locality, however, we have the report of the only surviving tree of the whole lot, but as it was partially protected, we are still in the dark as to the practical significance of the fact. Unfortunately, the

most promising locality perhaps, Santa Rosa Island
actually untried, the plants suffering permanent injury
voyage from Santa Barbara. Such was also the case with
to a very sheltered locality in the San Gabriel Valley, S
Villa, where the Chirimoya apple is flourishing.

To draw any definite conclusions from these scanty
alone seems to be premature; but comparing them with ou
vations, and also with the Australian and Indian experien
in their respective reports, we venture the opinion that
ularly well sheltered locations, subject only to very light
here and there in the so called warm belts in a number
may, by careful cultivation and attention, be made to
bark tree (*C. succirubra*), and the still hardier variety,
(not yet grown here). Whether the cultivation of the
repay all the trouble necessarily attending it, it is diffi
when we consider that the price of quinine undoubte
greatly reduced when the enormous plantations in In
and Java, growing in perfectly adapted locations, com
bearing; nevertheless, it seems a pity that the subjec
dropped altogether without arriving at definite concl
have still on hand a limited stock of plants, which coul
if the proper appliances for their propagation could
Without this, they will gradually be lost. It must be
that our experiments here with the Cinchonas have been
atively little expense to the State, having been made in
with other plants, and in the same house, while the seed
tion. A small appropriation—say of $1,000—would enab
the necessary additional building, and to increase the s
to supply such localities as our previous experience has
be favorable.

The *Camphora officinarum*, or Camphor Tree of Japan
is the source of the genuine camphor of commerce. It i
ingly handsome evergreen, belonging to the Laurel famil
fore a relative of our California Bay Tree, which it resembl
in manner of growth. It seems perfectly adapted to the
of California, thriving in similar soil as the Bay, and ex
far in rapidity of growth. In Berkeley and other locali
San Francisco Bay, beautiful and luxuriant growing sp
met with here and there, and an instance of a fine larg
feet high is known in Sacramento Valley. Although t
forests of the Island of Formosa, the Chinese Coast, and
very extensive, the increasing demand for camphor in ne
(for instance, in the manufacture of celluloid) makes it v
that its price will increase in a few years. Aside from the
drug, the wood, which generally does not enter into its m
has a high value for a number of purposes, and perhaps
compensate for the cost of rearing the plantation, leavi
young branches, and foliage (the camphor-producing m
nominal cost. It seems, therefore, that every inducemen
tree on a large scale exists here. As the yield of camphor v
erably in different localities, it would be wise before plan
extensively to rear a few for analysis—sufficient materia
curable in a couple of years from a few young trees. Step
taken to have the percentage of camphor of a young tre
Berkeley ascertained, and we shall, therefore, before lo

value of the tree for this purpose from one locality in California at least.

The Camphor Tree is easily propagated from fresh seed in a moderately warm soil (sowing under glass is here to be preferred), but, like all seed of this kind, they spoil very easily, hence the failure often met with. It may also be propagated from cuttings of hard wood, which make fine plants, but they are rather difficult to root. We are sorry to say that our limited stock allows us to distribute but very few of this useful tree.

The Caper Bush (*Capparis spinosa*) is a little slow here, but bears the climate comparatively well. Though the severe frost last winter cut it down almost to the ground, it made a vigorous start early in the season, and showed flowerbuds already in June, continuing to bloom until October. The Caper Bush can be raised from seeds, but is far easier propagated from soft-wooded cuttings, planted in a frame under glass; they strike readily, and the plants raised in this manner are of much faster growth. The most natural soil for the Caper is a sandy, rocky, and dry soil, and it is said to live even in the most arid regions. We have here, with care, succeeded in growing it in a heavy loam. Both the *Capparis spinosa* and the variety *inermis* (thornless) are on hand in small quantities for distribution.

The Melon tree, or papaw (*Carica papaya*), mentioned in the last report, has unfortunately not proved any more hardy than the Cinchona or Custard Apple, but in such favorable localities as have proved suitable for the latter, it will undoubtedly thrive. The peculiar properties of this tree render it as interesting as useful. It is well known in all tropical countries in which it has been acclimated. All parts of the plant are pervaded with a peculiar principle (very rich in nitrogen and probably allied to pepsin), having a powerful influence on muscular fiber, causing it to separate; hence its value, especially in tropical countries, for making fresh and tough meat tender. Originally from America, the *Carica* has spread widely all over the eastern hemisphere, and testimony from nearly every tropical country, and from some extra tropical ones, confirm the story of its wonderful properties. We have, ourselves, tried the experiment with the toughest piece of round steak that could be procured, by placing the meat between layers of the green leaves (the mode commonly used), leaving it there for a few hours, and were surprised to find the steak, when cooked, as tender as the best meat. For any one especially interested in this subject, a paper written by Dr. Holder, on the juice of the papaw, can be found in the third volume of the Wernerian Society's Memoirs, an extract of which is given in Colonel Drury's "Useful Plants of India."

We have here grown from seed, a few plants intended for distribution to suitable localities.

The Argan Tree (*Argania sideroxylon*, of Western Barbary), is unaffected by our frost here, but it is a very slow grower. Although quite useful in its native country, as the fruit is used for cattle and the seeds to press oil from, it is very questionable if it ever will find much favor in California. For the regions adapted for it, viz.: dry rocky hills, the *Carob Tree* undoubtedly will prove a better investment. The latter, which we have grown for a few years, has proved hardy enough here, and even in an unfavorable soil, a fair grower, after being established. We have been advised of a case in the Santa Cruz Mountains, of bearing trees of the Carob, but have failed to learn the exact locality.

TANNING MATERIALS.

That an easily available tanning material would be welcomed in any country can hardly be doubted, inasmuch as the demand increases with the growth of population, while the natural supply decreases almost in the same proportion. Here in California heavy inroads have been made on the so called Tan-bark Oak (*Quercus densiflora*), the chief source of tan-bark, as well as on the less efficient Black Oak (*Quercus Kellogii*), and unless some other source is found, it is as to *Q. densiflora* only a question of time for when its supply will give out. Of other native trees suited for tanning, the native evergreen sumachs were analyzed in the laboratory here under your supervision, and their percentage found rather low. It is therefore not a matter of small importance, that the South European Sumach or Tanner's Sumach (*Rhus coriaria*) has been found to flourish in this locality, and therefore probably will prove to be adapted to the coast region of the State generally, its true place being no doubt on our poison oak lands. Its growth here in Berkeley has been astonishing, and it has proved itself hardy in the open air, even when very young. The manner of growth of this Sumach is such as to render it of easy culture; pieces of subterranean runners readily forming plants in one season. Being of a somewhat succulent nature, and perennial, it is eminently adapted to special culture, much more so than the shrubby and woody species, the natives of the Eastern States and California. Attention was already called to this plant in 1860, by Mr. S. B. Carsons, of Flushing, New York, in a report to the United States Agricultural Department, in which he writes as follows:

The Sumac (*Rhus coriaria*) is a small shrub, growing from two to three feet high in a season, and is used for its astringent qualities by the tanners and dyers. The cultivation is chiefly confined to the vicinity of Palermo and Aloamo; the product of the last, being esteemed the best. It is sometimes adulterated with leaves of the cutish and myrtle trees. A soil of moderate depth is required, and not too rich, for when of too luxuriant growth, the tannin will become diluted; manure, therefore, is never used; stony ground will do very well, although the sumac near Palermo was on a good loam. It will not bear much water, and is therefore better on a hillside with southern exposure, as the more sun it receives the more tannin is formed. It could, doubtless, be grown with profit on the dry lands in our Southern States. The proper adaptation of the land can be ascertained by testing the leaves with sulphuric ether. In the best sumac, one hundred grains of the powdered leaf should give from thirty to thirty-five grains of tannin; use as much sulphuric ether as will dissolve the sumac, or pass it through the sumac until it runs clear, then draw off the ether by heat, and the deposit will be pure tannin.

The soil is prepared in the same way as for potatoes, with furrows, from two to two feet and a half apart, in which, in January and February, the young suckers are placed about two feet and a half apart in the row. In August of the first year, the leaves on the lower part of the branches are drawn off with the thumb and finger, leaving a tuft on top. In October, the whole head is taken off, or sometimes broken and left hanging by the bark till dry. In the second year, in June, the branches are stripped of ripe leaves, and in August, as soon as the whole plant is mature, it is cut with a sickle down to six inches. It is then spread out, dried thoroughly on each side until entirely cured. The June gathering is omitted in many cases, when the plants are not strong. After being dried, the branches are put on a floor and thrashed, when the leaves will separate from the wood, which is of no value except for fuel. The leaves are then ground between two millstones, one of which is on edge and revolving around a center. We visited a mill driven by steam power, which threw out the powdered sumac in large quantities. The air was filled with fine particles of dust, which covered our clothing and entered the lungs. It is not injurious, however, for although it seems suffocating, the workmen will sleep three or four hours successively in it, and are always remarkably healthy. They were particularly exempt from cholera.

The leaves are readily reduced to powder, while the stems are not. These last are then separated by sifting, and the pure sumac is placed in bags of one hundred and sixty-three pounds each for shipment. A sumac plantation will produce a good article for ten years, and a poorer one for ten years more. The sumac soil will not produce sumac a second time, unless cropped with something else for twenty years, nor is it then so good as soil that never has produced sumac before. It requires the usual cleaning, and is hoed in December, March, and May. Two thousand pounds of ground sumac to an acre is considered an average crop.

ing that this plant is well adapted to our coast climate, the
nsideration is, whether it will pay to grow it. This, I think,
nswered in the affirmative; we have plenty of poor, old
astures too exposed for grape and fruit culture, where this
would find its right condition. According to the last statis-
tanning materials, it appears that in spite of the large local
ion of native sumac in the Southern States, the European
till commands double the price, or $100 a ton; and that the
tion in 1877 amounted to 11,000 tons, at the value of $1,100,000,
erican product being perhaps half of this.*

teadily increasing demand for Sicilian sumac, while at the
ne a great quantity of American sumac not heretofore used is
ed, must be accounted for by the inadaptability of the latter
to tanning leather a pure white color.

gh the American sumac, according to the analysis,† contains
nnin, it is accompanied by a coloring matter that causes the
to be stained; hence the demand for European sumac. The
endations by the U. S. Agricultural Department to gather
ac early in June to obviate the coloring matter then not
does not seem to take in consideration the vast amount of
ntained in the young parts, making the bulk of raw material
greater, and consequently the gathering of the same amount
n at that time much more expensive. The local demand on
st alone, would seem to justify an investment in a sumac plan-
s the outlay is very small, a few dollars worth of seed being
t to start plants for an acre. When planted, this kind of a
on would be little trouble, and a net profit of about $50
ndoubtedly be derived, placing the gross receipts at $100,
eems a low estimate.

er important source of tannin, are the Australian Acacias, of
p termed Wattles (*A. decurrens*), the Black Wattle, and *A. Pyc-*
or Golden Wattle. The products of these, under the name of
bark, finds its way to the London market, where its price is
a ton. The facility with which Acacias are grown here along
t is well known, and naturally recommends them as shelter
ound orchards, if it were not that they are great breeders of
sects. This, however, would not be any objection to rais-
hem for sake of the bark, as the scale hardly affects the tree
y until large enough for use. Besides, by being careful to use
me-raised trees, this difficulty might be entirely obviated.
n Mueller, the distinguished botanist, has ever since he caused
to be analysed, urged their planting in their native home.
his the first time that the planting of the Wattle has been
recommended, and the reason for our doing so again, is that
yet failed to hear of any large enterprise in this direction.

ollowing estimate of the cost of a plantation of a hundred
taken from the report of the Board of Inquiry appointed to
ate this subject in Australia:

acre planted with Black Wattles, ten feet apart, would carry
ndred trees, and at the end of the fifth year would yield fifty-
nds matured bark, stripping every third tree; three hundred
rty-three tons would be obtained from a hundred acres; this,
ton, would give for the first stripping £1,332.

gricultural Report for that year.
gricultural Report, 1877, page 78.

In the sixth or following year a similar number of trees would be stripped, the bark having increased in weight, say fourteen pounds; the increase yield of the second crop would make four hundred tons, at £4 per ton, £1,600.

In the seventh year the remaining trees would be stripped, from which a still greater increase would be obtained, say four hundred and eighty tons, at £4 per ton, £1,920.

The aggregate yield during the first eight years would be one thousand two hundred and fifteen tons, £4,852.

The expenses are calculated as follows:

Rent of a hundred acres, at six shillings per acre per annum	£24
Plowing one hundred acres in drills, ten feet apart	25
Sowing of wattles and actual cultivation, seed included	37
Pruning the trees, taking off useless growth only necessary for two years, at ten shillings per acre	50
Supervision for eight years, nominal, say £50 per annum	80
Incidental and unforseen expenses	27
Interest on the whole amount expended during eight years	240
Actual cost of stripping and carting	1,515
Total	£2,637
Profit balance, exclusive of improvements or supplementary savings	£2,637

Though this estimate requires considerable modification in its special items, it does most likely not exceed the probable cost here; the estimate of land, for instance, may be reduced, for no doubt one hundred acres could be bought for the £250, or eleven dollars an acre; land suitable for this purpose exists in large quantity in different counties, such as Santa Cruz and Monterey, and others, in regions partly covered with pines, where the soil is too poor for any kind of fruit or grain.

In the Australian estimate the expectation is to raise new trees from seed to replace those cut down. This, perhaps, would not be needed, as the Wattle here almost invariably sends up sprouts from the root, which grow with greater rapidity than the seedling; such, at least, is the case in good soils. It will also be seen that in this estimate no allowance is made for the value of wood, which from trees eight years old would, in California, be considerable. The *Acacia decurrens* is comparatively little seen in California. The *A. dealbata*, or Silver Wattle, generally known by the name of *A. mollisima* in the nurseries, being the one most commonly planted.

The two are most easily distinguished when in fruit, the Black Wattle being characterized by having the pods contracted between the seeds, making it next to impossible to get the latter out without breaking the pod altogether. *Dealbata*, on the contrary, which is also known by the bluish white hue of the foliage, has the seed rather loose in the pod. This latter species, so often planted around San Francisco Bay, and confounded with the other, is according to Ferd v. Mueller, very valuable for fuel, but not rich enough in tannin for tanning purposes. As regards the *A. Pyconantha*, it is known that it will grow equally in poor soil, but it is of rather small size for profitable production.

We have gathered a small quantity of seed of the *Acacia decurrens* this year, intended for distribution and propagation.

review the various fiber plants of the world, it seems
n, that save those of properly tropical nature, California
suited to them all. Fiber of great length, of the com-
inum usitatissimum), has been produced in this locality,
ported varieties from Europe presenting a striking con-
of the acclimated variety, thus far cultivated for its seed
ber of the latter being but from one third to one half
the Royal (a white flowering variety), and a Russian one.
raising of flax fiber in the various parts of the State
le profitable, is difficult to say, and can only be deter-
ual experiment; for this purpose we have grown a small
eed of both the Royal and Russian, for distribution to
ing to try them.
vs exceedingly well and certainly deserves more attention
hus far received.
nd Flax, or the New Zealand Flax Lily (*Phormium tenax*)
ant of high value. Aside from its manufacture into
especially valuable as a ready-made tying material for
neyard and garden, as the leaves may be used imme-
being cut from the plant, being readily split up into
y desired width and of extraordinary strength and
That the usefulness of this plant for such purposes
ig have been overlooked is remarkable. As an ornamen-
as been known for many years in this State, and beauti-
s ten to twelve feet high can be seen in the Washington
right in the heart of San Francisco, and in many private
akland.
that in New Zealand there are two different varieties,
low-growing, producing the finest fiber, while the low-
ound skirting the swamps produces a more abundant
naterial. It has been stated that it will not live with
nanently sunk in water; this is quite likely, but that it
vhen covered for five or six months in a creek, we have
to prove here. Its place on the farm therefore is along
toms and banks, where it can serve a twofold purpose,
enting the creek from undermining the banks and also
seful strong tying material, ready at any time. But as
and, its use here should not be confined to the mere
eds; its cultivation on a large scale would no doubt
rofitable, since plenty of land suitable for its production
d along our river bottoms subject to periodical overflow.
has within the last years been exported largely from
, bringing in London £19–31 a ton; the best fiber is made
the native Maoris, who wear it for clothing; but
successfully employed in its manufacture. The plant
ily increased by seeds, but best by division. It pre-
sandy loam, but will grow in a variety of soils, dry or
ovided they are deep. As this plant is of especial use-
re glad to be able to furnish for distribution a number
ants.
ehmeria nivea), also called China Grass Cloth Plant, is the
plant of India, China, and Japan, a close relation of the
s most promising of all textile plants thrives even in as

cool a climate as that of Berkeley, and will with irrigati
least two crops a year, yielding about 6,000 pounds to th
dried stalks, or about 800 pounds of prepared fiber,
market $100. But it is in the irrigated valley of the
this plant would be most profitable, as it would, no dou
duce four crops in a year.

The great value of the Ramie fiber has tempted a numb
in California to grow this plant, and we believe that it
proved a success wherever tried, both in central and s
nia. The impossibility of manufacturing a product che
compete with that of India, either hand-produced or p
by machinery, has thus far discouraged all attempts fo
culture. Although machines for this purpose have b
none as yet are known to have proved fully satisfactor
to the fact that cheap hand labor is as yet absolutely
manufacture must at present be confined to countri
such. The large premium offered for an efficient machi
been paid. It is to be hoped that the earnest efforts of se
here in California will be able to solve this problem
seems that Mr. W. Hollis, of San Francisco, who for seve
studied the subject, has achieved most flattering resu
simple way, according to his own statement. We are
sion of the particulars of this process, which is now be
but it will suffice to say that Mr. Hollis has produce
fiber from Ramie grown around the bay, and that he co
principal difficulties settled, and is now making experi
the most satisfactory location in the State for its culture

Another near relation of *Boehmeria nivea* is the *B*
described in the French and German catalogues as the
superior to *nivea*. We have been unable to procure fres
variety, to compare the two. In the report of the U
Agricultural Department the opinion is confidently ex
the two are the same—at least producing an identical fi

Besides the above mentioned fiber plants, attempts to
have been made here for two successive seasons, r
complete failure, it being impossible even to raise a pla
high, and further trials here must be considered useles

The success of cotton growing will soon be definitel
and it need only be mentioned that this locality, a
trials, must be considered absolutely unsuited for its
with it doubtless the entire coast region.

MISCELLANEOUS PLANTS.

The Insect Powder Plant.—The genus *Pyrethrum*,
Feverfew of our gardens belong, embraces a number of
or less efficient as insecticides. Of these especially the
ariæfolium (of Dalmatia) identical with what was
under the name *Caucasicum*, has found great favor i
and its culture in Merced County, as well as in
County, has assumed large proportions. The cult
species has, as far as we know, only been carried on o
where plentiful irrigation has been resorted to. While
on such land may be somewhat more plentiful tha
tainous countries, with less heat, a shorter season,

moisture, the very fact that nearly all the species of *Pyrethrum* ves of the mountains, would seem to indicate that the hot vould not be the best place. Like nearly all mountain xcept true swamp plants, the *Pyrethrum* must have a very ined soil and does not tolerate stagnant water, a condition to t may readily become subject where irrigation is practiced. that many of the mountain plants, as for instance *Arnica*, heir peculiar properties only under climates and condi-nilar to that of their native home, speak strongly for seeking per conditions for the *Pyrethrum* in the moister part of our ange. Experiments on a small scale in the Santa Cruz ns, indicate that the *P. cinerariæfolium* is well adapted to nate. Young plants set out in the early spring have passed the dry season without water, as well as plants of the same set out at the same time in our heavy loam at the experi-grounds, where they were irrigated several times and would ed without it. The *Pyrethrums* are easily grown from seed. own in frames early in the Fall, in a light sandy soil, plants ough to set out can be had in March. They may be then out into boxes (three inches apart), from which they finally splanted; this makes better plants, but is not actually neces-he month of March seems here a good time to set out both this other species. The beds for them should be worked very l manured, if naturally poor; the distance apart should not ian eighteen inches; the first season they require considerable n, as hoeing, irrigation, etc., and seem not to grow much in but are forming strong roots. In favorable mild seasons w all winter, and in April, thirteen months after being set *oseum* commences to bloom, while *cinerariæfolium* does not ce here before the end of May or first part of June.

e species cultivated here *P. cinerariæfolium* is the least for division, while the red flowering *P. roseum* and its vari-*eum* divide very readily, making this mode of propagation kest and perhaps the best. As regards the adaptability of the o culture for profit, it seems evident that it cannot compete *cinerariæfolium* even in a heavy soil, to which it is appar-tter adapted than the last named species. Its yield, in spite rger flowers, is not one third of that of *cinerariæfolium*, and ts product should prove far superior, there cannot be any ient to grow it on a large scale for profit, judging from its r here. It was anticipated that it would give a good second it only a few plants, after all care and watering, flowered y the second time. While its pretty flowers (varying from o deep crimson) appearing in succession for two months, nmencing in April, make it a highly attractive plant, this self renders it inferior to the *cinerariæfolium*, in which the the flowers are ready for harvesting at once, allowing the use inery for the purpose. The soil best adapted for the *Pyre-* a sandy loam, although with care we have grown both vari-a heavy loam or adobe. In such soil they require irrigation imes during the season, the first time before they commence r. When to apply water (especially on heavy soil) requires able judgment, as the *P. cinerariæfolium*, when once suffering yness, dies very easily. The *Pyrethrums* are perennials in a climate and soil, but in heavy soils are of short duration.

The importance of the insect-powder plants for Califo consumption alone, promises to be great, apart from tl export, the usefulness of the product for a variety of pur it highly probable that with the increasing supply the grow. Preference ought, also, be given to the Califor because of its freshness. As in related plants, the act here is a volative oil, which escapes constantly through nute opening, and is also made inactive by gradual cor resin. Hence the strength of the powder is inversely to its age. As regards the manufacture of the powder, tion, etc., we will refer the reader to several articles b and it need only be mentioned that so far only the flo utilized for the production of a first class article.

Bamboos.—The importance of the Bamboos is justly to attract the attention of the people of the United Sta large importations of these useful plants have been ma last few years, notably that by the Department of Agri Japan, part of which was distributed in California duri of 1881. The value of Bamboos to a country like Cal rally lacking hard woods, can hardly be overestimated. of uses made of them in the eastern hemisphere is astoni anything imaginable being made from them. Espec civilized countries their importance is very great, an would consider themselves badly off without the Bam all the household articles being made of them, includi itself.

Speaking about the uses of the Bamboo, Col. Drury, in Plants of India," says:

The purpose to which bamboos are applied are so numerous that it would out an object in which strength and elasticity are requisite and for whic an objection, to which the stems are not adapted in the countries where young shoots of some species are cut when young and serve as asparagus stems, while green, form elegant cases, exhaling perpetual moisture, capab fresh flowers for hundreds of miles. When ripe and hard they are converted and quivers, lance shafts, bed posts, walking sticks, poles of palanquins, etc. sides the Malays make wonderfully light scaling ladders, which can be conv where heavier machines could not be transported.

Bruised and crushed in water, the leaves and stems form Chinese paper, th which are only improved by a mixture of raw cotton, and by a more carefu leaves of the small species are used by the Chinese for lining their tea chests. and the partition knocked out, they form durable water pipes, or by littl made into excellent cases for holding rolls of paper. Split into strips they aff material for weaving into mats, baskets, and window blinds, and even t Finally the larger kinds are exquisitely carved by the Chinese into beautiful

No plant in Bengal is applied to such varied purposes as the bamboo. Of ments of weaving—the posts and frames of roofs of huts, scaffolding for stages, raised floors for granaries, stakes for nets in rivers, rafts, masts, yard boat decks. It is used for building bridges across creeks, for fences, as a leve irrigation, and as flag poles. Several agricultural implements are made of it litters, and biers, and fishing rods. A joint of bamboo serves as a holder for ments, and tools. The joint of the bamboo answers the purpose of bottle, as a measure for solids and liquids in bazars. A piece of it is used as a blowpi a distillery apparatus. A thin slip of it is sharp enough to be used as a kn betel nuts, etc. Its surface is so hard that it answers the purpose of a whets ryots sharpen their bill hooks and sickles.

The above extract conveys an idea of usefulness of tl half-civilized countries, and must necessarily suggest here, among which that for light, durable furniture, the least important. It is, therefore, not a matter of s that several kinds of large Bamboos, from China, Japa

not alone have proved hardy, but flourish in various places in California. The most interesting case that has come under my observation, where the Bamboo has come to perfection, is from the garden of General Kirkham, Oakland. Here a complete little grove of Bamboos can be seen, with canes averaging twenty to thirty feet in height, and one and a half to two and a half inches in diameter. It appears that the original plant of the Bamboo, the botanical name of which I am unable to give, was brought, about fourteen years ago, from Hongkong, China, and planted in a bed close to the lawn. For years it only produced very feeble canes where it was planted, although the gardener, who was cutting the lawn sward, twice observed shoots in the grass, but they were always cut off with the mower, and no attention was paid to them. About two years ago, however, the shoots became so vigorous and strong, that it was concluded to leave them undisturbed. Left alone, they grew up with astonishing rapidity, some of them reaching a height of twenty feet in a couple of months. This year the size and rapidity of growth has increased still more, two joints (seven and eight inches) being the growth of many of them in a single night, hence equaling almost the growth of the tropical Bamboo of India. This Bamboo has, during the two years' growth, run about sixty feet, and the subterranean shoots can be seen sticking up everywhere in the adjoining walks, while the shoots themselves appear to push through the solid walk just as easily as in the sandy loam. Although this Bamboo has been very slow in coming into vigor, the adverse circumstances it has had to contend with add to the testimony of the wonderful hardiness of these plants.

Another illustration of Bamboo growing is presented at the gardens of Mr. Chabot, of the Oakland Waterworks. We see here, most strikingly, what can be done when artificial means, especially heavy manuring and abundance of water, are resorted to. Mr. Chabot's collection contains a large number of species, from the so called Bamboo grass to the large tree Bamboo, becoming forty feet high. The majority of specimens, however, are of the so called Metake or Medake, one of the most useful and also one of the largest kinds. Of these some clumps planted only about eighteen months ago show canes more than an inch in diameter. The variety called Moso, the kind of which principally the young shoots are eaten, is producing its heavy but only moderately tall canes in abundance, but still shows less than any the appreciation of the careful culture and irrigation; at least judged by a plant of this kind growing at the experimental garden, which has been watered a few times during the season, and seems equal to it almost in every respect.

The black stemmed species (*Phyllostachys nigra*) is also growing most luxuriantly at Mr. Chabot's. This Bamboo is very hardy, and would doubtless be able to endure the frosts of the northern counties of this State, having been found to survive severe frosts in south of France and at Vienna. Although not very large, its pretty jet black canes would doubtless be found useful for a number of purposes. The most curious, although not the most useful, is a species with indented joints, in Japan called Ka-mo-no-ko, and there principally used for walking sticks. A visit to this place would repay any one interested in this class of plants.

The collection of Bamboos at the garden of economic plants, contains at least eight species—perhaps more—some being in a stage

where they are very difficult to identify. Beside the kind called Moso, Madake, and the black stemmed, there are at least five others. Of these by far the most promising is the *Arundinaria falcata*, from the Himaleh mountains, where it is called Ringal or Nigala Bamboo. This species is very hardy, growing at high elevations, where the snow lies for some time during the winter. It is of slender growth, the cane not exceeding four inches in diameter, but becoming as tall as forty feet. The canes are strong and durable, and utilized for a variety of purposes, especially for bridge building. The specimen growing on the grounds now is a seedling in its third year, the seed being a donation of Ferd. v. Mueller, through his friend Dr. H. Behr, a gentleman to whom the garden of economic plants is indebted for a number of rare and valuable plants. Although very sparingly irrigated, this Bamboo has now canes nine feet long and about three eighths of an inch in diameter, very strong and solid. Of these, last spring, a crop of about thirty were produced, and now again, in November, another is appearing. Unlike most of the other Bamboos, the Nigala Bamboo makes all its canes at one time, or twice a year. It seems here to delight in the cool foggy weather, and has never been affected the least by any cold or wind. The graceful curving canes seem to be too flexible to give any resistance to the wind, and to-day, after one of the severest storms ever experienced in Berkeley, hardly a leaf is torn. This Bamboo is of very easy propagation, dividing readily when young, and plants propagated in this manner are of course much more rapid-growing than the young seedlings, which during the first year are extremely slow. For the cool and moist part of the Coast Range this species is especially well adapted, and we only regret that our stock of this plant is not more extensive.

All the other Bamboos here were planted somewhat later, and although in better prepared soil, have, with a few exceptions, moved very slowly as yet; they were all (save the *B. stricta*, which was raised from seeds) imported from China and Japan two years ago, most of them being large stumps with poor roots. From the Government importation were obtained three kinds, one being evidently Metake; another, named Moso, is totally different from what the Japanese call Moso. While none of these have made any growth to speak of, the third kind, termed *Tadake*, a slender species, is doing exceedingly well, but it is evidently only an ornamental plant. A kind from Chee-Foo, China, is apparently a large Bamboo, and bears strong resemblance to the species cultivated at General Kirkham's, originally from Hongkong. Specimens of the Moso, spoken of before, and younger clumps of the Metake, together with the black-stemmed Bamboo donated by Mr. Chabot, appear to have established themselves, getting ready for a tall growth next year.

Finally, the *Bambusa stricta* deserves mention. Unlike all the rest, this species seems not to have heat enough to thrive, and has made extremely little growth; that the low temperature is the cause, is confirmed by Mr. Chilson, of Anaheim, Los Angeles County, who having received a plant of this kind from the department, reports it doing as well with him. This species bears the reputation of thriving in dry and hot localities, and will therefore probably be suited well in the southern part of San Joaquin Valley, provided it will endure the winters there.

The instances given are sufficient to prove adaptability of a large

er of Bamboos, especially Japanese, to at least certain portions ifornia, and should encourage culture trials with the numerous oos found in India, South America, and Mexico, growing at ltitudes, many of which would be equally well suited to our e.

r Bushes.—Under this name, several shrubs, especially belong- the genus *Atriplex*, are in the Australian alkaline plains to furnish excellent fattening pasture for sheep and cattle. gh the kindness of Dr. H. Behr, of San Francisco, we obtained f two species of this *Atriplexo-esicarium* and another *Atriplex*, the s name of which was not given, and succeeded in raising a num- plants of each kind. Planted in the garden of economic plants, rew finely, although not receiving much care. It was not until ring that we had an opportunity to get them tried in alkaline y Mr. G. Schoof, of San Francisco, who had at Alvarado, some dly alkaline lands, where hardly any thing but salt marsh *Salicornia*) would grow. The result of the experiment of grow- e above plants has been very successful; especially the un- l species of *Atriplex* so satisfied Mr. Schoof, that he intends to gate the species as fast as he can (it grew with facility from gs). Not only does the successful growth of the plant, which rtually left to itself in a hard, dry soil, prove it to be desirable aline land, but the relish with which cows would eat every e of it would seem to make it a pasture plant worthy of ex- e culture. The importance of a plant of this kind to many regions can hardly be over estimated, and Doctor Behr, who has been tired of urging the trial of these salt bushes, deserves redit for his efforts.

K. McLennan, who has direct charge of the propagation houses, ded me greatly in all these matters, and deserves great credit, ly for the faithful discharge of his regular duties, but for the siasm with which he enters into the ulterior objects of the beyond the limits called for by his engagement.

W. G. KLEE.

EMBER 12, 1882.

LIST OF PLANTS

ON HAND IN LARGE NUMBERS FOR DISTRIBUTION---READY FEBRUA

Phormium tenax, New Zealand flax. *Boehmeria nivea*, the Ramie. ***Psidium pyri***
shaped Guava. *Rhus Cotinus*, Venetian Sumac. *Eucalyptus* ***marginata***, the Jarr
ern Australia, for localities with mild Winters. *Planera* ***cuspidata***, Japanese oli
Grapevines grafted on roots of the wild California grapevine (***Vitis Californica***).

IN SMALLER NUMBER.

Arundinaria falcata, the Ringal or Ningala Bamboo, adapted for the cool
parts of the Coast Range; stands frost well. *Bambusa stricta*, for the southern cou
paris spinosa, Caper Bush. *Anona chirimolia*, Custard Apple, for very sheltere
Angol Peach, a supposed wild species of peach of good quality. ***Sophora Japonica***, J
Wood. *Carica Papaya*, the Papaw or Melon Tree of the Anticles. ***Camphora***
Camphor Tree of Japan. *Salt Bushes* (Atriplex Sp.), for alkaline soil. ***Cinchon***
(Quinine) Peruvian Bark Tree; location subject to our own choice.

LIST OF DONATIONS

OF SEEDS AND LIVING PLANTS, RECEIVED SINCE DECEMBER,

From J. G. Lemmon, Oakland:

January, 1881.—Seeds of *Sapindus marginatus* and ***Dasylirion Wheeleri***; pla
um mohrioides, and a new species of *Heuchera*; seed of a ***Sophora sp.***

From Mr. W. Ashby, Berkeley:

Plants of *Clerodendron Bungii*; several new varieties of Fuchsias; the following fe
lepis exaltata, *Gymnogramme decomposita*, *Palypodium aureum*, ***Platycerium alicorne.***

From Mr. Rhodes, of Carpinteria, Santa Barbara County:

January, 1881.—Bulbs of Tuberoses; seed of *Delphinium* ***cardinale***, ***Rhus integr***
ruary, 1881.—Seeds of Mango and *Clianthus Dampierii*; seeds of various wild flowe

From M. A. Chabot, East Oakland:

January, 1881.—Various Japanese shrubs and trees; two Camphor Trees; tw
two Japanese Persimmons; two plants of the Bamboo called Metake; one Black Ste
boo; one Moso Bamboo; Tea Bushes; *Pueraria* Roots (starch plants from Japan);
Trees; ten pounds of Rice Seed.

From Mr. A. K. P. Harmon, Oakland:

Cuttings of a large number of exotic plants.

From Myron H. Savage, Lemoore, Tulare County:

Seeds of the Mesquit, Straight Pod and Screw Bean.

From Mr. C. T. Hopkins, San Francisco:

November, 1881.—Cuttings of the Huasco Grapevine, from Chile.

From Mr. Henry Natkemper:

January, 1881.—Plants of *Azalea occidentalis*.

From Dr. Ed. Palmer, of Cambridge, Massachusetts:

February, 1881.—Seeds of *Yucca* species from Mexico; *Dasylirion serratifolium; Agave Lecheguilla*.

From Dr. H. Behr, San Francisco:

Seeds from Melbourne Botanical Gardens, viz.: *Bambusa Brandisii; Eucalyptus miniata; Dendrocalamus strictus; Myosotidium nobile; Pennisetum longistylum; Reana luxurians; Pennisetun typhodium; Panicum maximum; Cordyline sp.*, from New Zealand.

June, 1881.—Seeds of *Quillaya Saponaria* (Spanish or Soap Bark); *Xanthorrhœa australis: Atriplex sp.* (Saltbush, for sheep fodder); *Templetonia egena; Eucalyptus gracilis; Stenocarpus sinosus. Panicum sp.* (from S. Africa); *Acacia aneura; Cinchona succirubra* (red Peruvian Bark).

July, 1881.—Various *Amaryllis* bulbs; various native orchids.

From San Francisco Bulletin Company:

March, 1881.—Tubers of *Dioscorea batatas* (Chinese Yam); *Soja* Bean, from Japan; seeds of Dalmatian Insect Powder Plant (*Pyrethrum cinerariæfolium*); Tallow Tree; *Martynia proboscidea;* Camphor Tree (*Camphora officinarum*); Casaba Melon; bulbs of *Lilium longiflorum; L. long. var. eximium; L. auratum; L. Batemani* (all Japan Lilies).

From Mr. E. Wolleb, Fruitvale, Alameda County:

March, 1881.—Plants of *Pyrethrum carneum and P. roseum* (insect powder plants of the Caucasus).

From Mrs. James Williams, Santa Rosa, California:

March, 1881.—Plants of *Funkia ovata* and *cordata*; various cuttings.

From Dr. George Engelmann, St. Louis, Missouri:

March, 1881.—Seeds of the following Wild Grapes: *Vitis cordifolia, V. cinerea, V. riparia, V. æstivalis.* Also seeds of *Apodanthera undulata, Cucurbita digitata, Cucurbita palmata,* Sabal Palmetto, *Yucca Whippelei, Yucca angustifolia, Agave Virginiana, Agave Palmeri, Yucca aloefolia, Pinckneya pubens.*

From Mrs. McIntosh, West Berkeley:

March, 1881.—Seeds, *Carica Papaya; Anona Cherimoya,* Lime (sweet); *Psidium sp.*

From Mrs. C. Breman, West Berkeley:

Collection of new Tea Roses.

From United States Department of Agriculture, per Hon. Amos Adams:

March, 1881.—Three species of Bamboo; *Citrus triptera;* various varieties of Japanese Persimmons; Tea seed.

From Mrs. Brennan, of Oakland:

March, 1881.—Plants of *Begonia metallica; Eucalyptus citriodora.*

From Mrs. Chisholm, Berkeley:

April, 1881.—Seeds of the Tea Plant and *Citrus triptera.*

From Professor Riley, per Mr. Rivers, Curator of Museum U. of Cal.:

April, 1881.—Seeds of *Pyrethrum roseum* (Caucasian Insect Powder Plant).

From Hon. B. B. Redding, San Francisco:

April, 1881.—Seeds, *Pinus parviflora* (Matsu pine of Japan).
May, 1881.—Clump of Chinese Bamboo from Chee-Foo.

From General Coey, per Hon. B. B. Redding:

April, 1881.—Seeds of *Laurus sp.* (Nan-mu, of Western China).

From Dr. Phil. Poulsen, Copenhagen, Denmark:

April, 1881.—Seeds of *Fagus sylvatica, Picea excelsa, Pinus austriaca, Larix Europœa, Abies pectinata, Abies Nordmanniana, Pinus Laricio var. Corsicana.*

From Mr. Geo. Jebens, West Berkeley:

May, 1881.—Plants of *Primulda auricula.*

From Dr. Curl, New Zealand, per Mr. C. H. Dwinelle:

July, 1881.—Seeds of *Pittosporum tenuifolium, P. Eugenioides, P. Ralphii, Karaka of the Maoris, Corynacarpus laevigata, Edwardsia grandiflora, Ripogonum scandens, Podocarpus spicata, P. dacrydiorides, Dodonœa viscosa, Clianthus puniceus, Phormium tenax* (New Zealand Flax), Chinese Lentils, *Pomaderris apetala, Festuca duos, Schefflera digitata, Anthyllis vulneraria, Piper exelsum,* Vetch from Malta.

Later—*Podocarpus ferruginea, Melicope ternata, Myrtus bullata, M. obcordata, Alectryon excelsum, Coprosma lucida.* Grasses: *Festuca Billardierii, Agrostis stolonifera, Bromus ciliatus, Glyceria striata, Danthonia semi-annularis, Penisetum glaucum, Dactylis glaucescens,* Pesuto Grass, *Hierochloe redolens.*

From Mr. C. H. Dwinelle:

October, 1881.—Seeds of the American Papaw, *Asimina triloba.*

From Mr. Ed. Harmon, class of '83:

Seeds of Ivory Palm; various native Lily bulbs and plants.

From Consul Denny, Shanghai, China, per Hon. B. B. Redding:

Seeds—*Nephelium Litchi,* Chinese Nut, *Stillingia sebifera.*

From Mr. Zschokke, Bakersfield, Cal.:

December, 1881.—Seeds of "Thierle."

From Dr. J. H. C. Bonte:

January, 1882.—Seeds of *Yucca sp.,* from Arizona.

From Dr. C. C. Parry, per Rev. E. S. Greene:

December, 1881.—Seeds of *Olneya tesota, Yucca elata, Y. macrocarpa, Agave Palmeri, Dasylonirí Wheeleri, Burseramicrophylla, Tagetes Parryi.*

n Rev. E. S. Greene, Berkeley:

f *Agave Parryi.*

n Mrs. C. Carlton, Oakland:

1882.—Plants of *Clematis Jackmanni, Hypericum sp., Anemone Japonica;* seeds of *grandiosa.*

n Mr. James Shinn:

-*Nymphœa odarata.*

n Missouri State University, Columbia, Missouri, per Professor Husman, of Napa:

1882.—Collection, hardy deciduous trees and shrubs, viz.: *Catalpa speciosa, Taxodium , Morus moretti,* Russian Mulberry, European Alder (*Alnus glutinosa*), *Magnolia pur- agnolia acuminata, Sorbus Aucuparia, Acer platanides, A. campeste.* Eight varieties *a; Ulmus urticifolia, Betula lutea; Betula rubra; Sassafras officinalis;* Dwarf Service o, evergreens: *Chamœcyparis obtusa, Chœmacyparis plumosa var. aurea, Taxus brevi- cca aloefolia,* and others.

n Mr. Fox, per Mr. Wendell Jackson:

f *Koelreuteria polynoides.*

n Mr. Leonard Coates, Yountville, California:

382.—Seeds of *Fuchsia Kirkii; Anthropodium cirrhostum.*

n Mrs. Cleland, San Diego:

f Perennial Pea (*Lathyrus sp.*); Post Oak.

n Dr. Sachs, Santa Clara, California, per Secretary Bonté:

382.—Seeds of a Pacific Island Palm (*Pritchardia sp.*)

n T. C. Nevin, Los Angeles:

, 1882.—Plants of *Cotyledon viscida Wats., n. sp.*

n Dr. Harkness:

, 1882.—Seeds of various wild plants of the Sierras: *Ephedra, Ribes cereum, Cerco- , Oenothera sp., Amelanchier sp., Calochortus,* and others.

n Mr. G. W. Cox, Oakland:

ber, 1881.—Bulbs of *Lilium Washingtonianum.*
ber, 1882.—Native sp. of Mountain Ash (trees).

APPENDIX IV.

REPORT OF WORK DONE IN THE VITICULTUR
TORY, WITH RECORD AND DISCUSSION OF

PRELIMINARY REMARKS.

BY E. W. HILGARD.

The general objects and plan of the work hereinafter
been defined in a previous report, in which, also, th
obtained were given. Since that report, however, may
hands of many of those now interested in viticulture,
tion of the substance will not be out of place here.

The plan adopted in this matter is in conformity w
expressed in my previous report, and shared by the be
the State, viz.: that among the first necessities of the pre
of California wines in the world's market, is the esta
more definite qualities and brands, resulting from a d
edge of the qualities of each of the prominent grape va
their influence upon the kind and quality of the wine
before, or as the case may be, after fermentation; of t
required by each in the cellar, during the time of
finally, of the differences caused by difference of loca
etc., as well as by different treatment of the wines them

Heretofore, in the great majority of cases, the wh
qualities and brands has been in the hands of the wine
received from the producer indefinite qualities and
wines made from unknown mixtures of grapes, and
erned almost alone by their taste in the important matt
blends adapted to the taste of wine consumers. That
circumstances the result should not have been altoget
one, or most favorable to the market value of California
surprising. When the fermentation is once over, the m
period in the life of wines is past; and the corrections
made afterward, by the mere blending of ready-made
the education of a human being after the golden time
passed unimproved. Something can be accomplished e
the best possible results are rarely attained; and in o
the defects as much as possible, artificial aids and
methods are employed. Thus far the reputation of pu
taining nothing that is not of the grape—has been the
virtue of California wines, which has covered a mult
committed in their preparation. It is to be hoped that

will see to it that this reputation shall continue to be deserved, and that hereafter, their product shall be of such quality as not to be ashamed of its birthplace, or to stand in need of borrowing either foreign labels, names, or flavors.

To this end, a definite knowledge of the character and special wine-making qualities of each kind of grape serving in the preparation of wine, is indispensable. In the wine-producing countries of Europe this knowledge has been acquired by long experience; and chemical investigation has subsequently in a great measure ascertained the natural conditions upon which the atttainment of certain results in wine-making depends. The principles thus evolved can be applied to new conditions, such as those existing in California, and thus save to a great extent the laborious and costly experimenting which has been gone through heretofore, by formulating into generally intelligible rules the knowledge which otherwise usually remains the trade secret of a few experts.

The first step to such knowledge is to obtain a definite idea of the material to be treated; and curiously enough, however numerous are the analyses of ready-made European wines already on record, there are comparatively few cases in which the must from which they were produced was also investigated in so definite a manner as to lead to broad generalizations. Clearly, what is needed is that first the must, and then the corresponding wine of the more important grape varieties, should be made the subject of detailed investigation, and that the wine should have been produced from the must under definite, or definitely varied conditions, with absolute certainty of the purity of materials, as well as of the precise manner of operating in each case. This cannot, as a rule, be depended upon in large wineries, where the exigencies of the supply, pressure of work and weather, the necessary employment of raw hands, and above all, the necessity of yielding to financial considerations, imposes limitations and uncertainties that can but rarely be controlled at will. When this *can* be done, the large scale experiments are of course by far the more decisive and cogent, and of the greatest practical value.

In an experimental laboratory, the qualities operated upon are of necessity small; and it is highly important that allowance be made for this circumstance, as well as for other points in which the "wholesale" practice must always differ from the small-scale one; for instance: the management of the temperature of the fermenting room is much easier in a large winery than in a small experimental room and with small quantities of must, which are very quickly affected by changes of temperature, such as would have remained unnoticed and without influence upon the great masses in the winery. This difficulty is very apparent in the record below, and is strikingly exhibited in the graphic representation of the course of temperatures in fermentation.

Nevertheless, we are thus enabled to obtain a very close estimate of the results obtainable from a given grape-variety on the large scale, and of the part that each will play when blended either before or after fermentation. Few grape-varieties will, like the peerless Riesling, by themselves produce the best possible product. The art and science of blending is scarcely second in importance to the possession of good raw materials, soils, and climates; and while its last refinements depend upon a corresponding refinement of individual taste and judgment, there is a large part of it that can be

intelligibly codified, thus preventing a waste of good materials upon unmerchantable wines.

Even the most cursory consideration, however, shows that this cannot be the work of one or of even a few years; but, like all other agricultural experiences and experiments, must be extensively repeated in order to become the basis of general practice. The same grape-varieties grown in different localities and in different years will differ materially in their composition; and it is only by extended comparisons of these through a number of years that the accidentals can be definitely segregated from the essentials. Hasty generalizations, based upon limited experience, are the bane of all experimental work.

While then the following record and discussion furnishes a basis of definitely ascertained facts regarding some of the more prominent varieties of wine grapes now produced in California, it cannot pretend to do more than furnish useful suggestions, to be tested by practice, and if the means for the continuation of the work be furnished, to be farther pursued and enlarged in our laboratory.

Practically, the plan of work adopted was as follows: To make of each kind of grape, not less than seven gallons each of white, and of red wine; that is, of wine fermented on the skins for a suitable length of time, as well as such resulting from must freshly pressed. In the case of white grapes, this, of course, alters but little the ultimate tint of the wine, but imparts to it a larger amount of acid, of tannin, and of "body," or extractive matters; while in that of black, or colored grapes generally, the color extracted from the skins is added to the above ingredients, forming properly "red" wines. The difference, however, extends far beyond the mere extraction of the substances preëxisting in the grape; since especially the presence of the acids of the skins influences very powerfully the formation of the specific aromas, or "bouquet" of high flavored wines.

The above mentioned seven gallons of each kind of must, or wine, are divided between a five and a two-gallon demijohn, for the first or violent fermentation; while for the second or after-fermentation, after racking off from the lees, the five-gallon vessel, filled full, serves as the permanent receptacle. A constant daily record is kept of the temperature, condition, etc., of the wine as its fermentation progresses; the temperature of the cellar being kept, as steadily as possible, between 60° and 65° Fahr., up to the time of the first racking off.

The fresh or white-wine must, the murk or red-wine must pressed after the first fermentation, and finally the finished wine, are each subjected to analysis; the several wines being also ultimately tasted and their qualities recorded. The lees are also weighed and chemically examined to a certain extent. It would be desirable to carry all these examinations very much more into detail in certain cases, but the work involved proved to be beyond the power of a single person to carry out within a reasonable limit of time. Such details as are necessary to enable experts to understand the exact nature of the determinations, are given by Mr. Morse, who also discusses the mutual relations between the several ingredients of the musts and corresponding wines and lees, as shown by his results. The continuation of the work up to the last moment before it became necessary to put its record in shape for publication, and the simultaneous pressure of other work, has made it physically impossible for me to

so scrutinize this record as to enlarge the discussion into the practical application of the results. This I propose to do hereafter, as soon as feasible, through the medium of the public press; meanwhile leaving wine-makers to consider the facts as they stand, for themselves.

In the record giving the result of the tasting of the several wines, it must be understood that my individual judgment alone has been brought to bear on the subject as yet, notwithstanding repeated invitations to other experts to visit the laboratory and assist me in forming a correct estimate of the several wines. I hope that as regards those wines of which samples remain, this will still be done in the future. In the meantime, I have refrained from giving any numerical estimate of the quality of the wines, in deference to the possible better judgment of others. Those having contributed wines, who should desire to be more accurately informed in this regard, are of course entitled to such statement as regards their own wines, and will be furnished with a copy of the record upon application. It may be noted as a feature of the record as it stands, that only a few of the wines made in the laboratory from *single* grape-varieties only, have yielded a satisfactory result—the best being the Chasselas, Zinfandel, and Mataro, to which, of course, would have been added the Riesling, had it been among the grapes used. Certainly the need of judicious blending, in order to produce the best results, is most strikingly exemplified in this case.

There is one feature, however, which it may be best to discuss somewhat in detail at this time, on account of its direct bearing upon the reputation of California wines. I allude to the use of grape sugar, or rather commercial "glucose," in the wine-making, which has been brought prominently forward by the emphatic action taken by the St. Helena Viticultural Club, in reference to an attempt to inaugurate the practice in that neighborhood. The matter has been brought directly before this department by the transmission of two bottles of wine, marked respectively "one" and "two," by Mr. F. A. Pellet, then Secretary of the club, with the request for an examination, and a statement that both were made from the same grape, but that glucose had been used in one of the two. As there appears to have been some misapprehension in respect to the possible and actual result of such examination, it will not be irrelevant to discuss the subject somewhat in detail. The question of the admissibility of the addition of grape sugar is a vexed one in almost all wine-growing countries, especially since the introduction, on the large scale, of the manufacture of glucose from unobjectionable materials, such as the cereals, and in the United States especially maize. While on the one hand the definition of wine, as "the fermented juice of the grape," excludes *all* additions, yet it is incontestable that the peculiarities of some of the most highly prized wines are produced not only by artificial manipulation, but also—as in the case of champagne—by actual addition of an ingredient not naturally contained in the grape, viz., cane sugar. In the case of the sweet wines, evaporation of a portion of the must, as well as "fortification," are essential points; and it is contended that if the wine-maker is justified in regulating the amount of water in the wine at all, he may increase as well as diminish it, having his choice as to what he will take for his use. The same is claimed as regards the regulation of the amount of sugar and alcohol; the more as nature in some countries

is often very chary of that substance, and many vintages in ern portion of the wine-growing belt would be undrinka plied with no more sugar than a foggy autumn has develop. This "chaptalizing" of musts has therefore bec general practice in the northern parts of Germany and F its introduction has certainly resulted in the producti undrinkable wine in those countries. Unfortunately, the to resort to the simultaneous addition of water to increas *tity* of the wine also, has proved too great for the moral res large portion of wine-makers; the result being that the pays the price of wine for a corresponding amount of wa it would have been much cheaper for him to obtain fro pump, if so inclined. Hence this expansion of the "mu tion" process ("gallizing") stands in a much more q light, and is usually carried out in the privacy of the wi vaults; albeit there are, undoubtedly, cases in which a rea ment of the final product is thus secured. Still fart "down grade," the wine-maker resorts to "petiotizing," ing the pomace with water, once or oftener, and afte proper amount of sugar, fermenting it into what is prope never commercially, known as pomace wine; which con bulk of the "vin ordinaire" used by the laboring classes and Germany.

Evidently, there is nothing in these processes that co jected to on hygienic grounds. Nothing injurious is ad wine, and the lowest of pomace wines is certainly prefe horrible compounds, made out of whole cloth, withou shadow of a grape in their composition, the use of whic largely replaced by that of cheap "petiotized" wines.

In this, as in many similar cases, the objection lies no against the article itself, as against its fraudulent impos the purchaser for what it is not. If it were held that this chaser's lookout, fraud of all kinds and degrees would nanced. If it be held that "oleomargarine" is intrinsicall its sale as dairy butter is none the less a fraud. So s addition at all is tolerated by public opinion, it is sure no the point intended, but will be pushed to its utmost by t the less conscientious makers or dealers.

We may fairly sympathize with the Rhenish wine-m reluctance to permit a foggy October to deprive him of t his year's labor, when he can secure a fair and saleable b making up the natural deficiency of saccharine developm few hundred pounds of grape sugar. The whole country predicament, and is willing to have this done rather tha sour wine. There is little concealment about it, the amo in certain seasons forming the subject of newspaper discus time.

But how is this in California? It is simply idle to pre similar failure in the development of the saccharine subs occurs within the present limits of the wine-growing regio contrary, the excessive development of sugars is one of t California vintages, and the worst seasons—such as that hundred and eighty—still leave our musts far ahead of sponding ones of Europe, outside of the Mediterranean regi as experience has gone, there is no excuse for ever "cha

s by the addition of grape or any other sugar. The only the use of these expedients can be an increase in the of the wine; in other words, "gallizing" it by the addition ugar and water, with the presumable intention of selling iluted, natural wine, just as "butterine" is sold for dairy

nia wines are now on trial in the markets of the world. utation for purity has been among their foremost recomns, for until lately their quality has but to a limited degree ded the approval of those accustomed to European vintages; use of any natural or irremediable defects, but simply f improper treatment of the raw materials, and of the inferihe Mission grape for the purposes to which it has been put. ot afford for a moment to detract from what *prestige* our *ve* obtained, by casting a doubt over their reputation as . Until they shall have reached the dignity of being sold eir own name alongside of those of Europe, instead of being under foreign labels, our wine-growers are most deeply and nterested in keeping glucose and all crookedness connected , beyond the Rocky Mountains.

dwelt somewhat at length upon this subject because of a hension on the part of many well meaning persons of the s for the objection to the use of glucose. It is not that it can d to be injurious to health (although "gallized" wine notoils where a tonic is wanted), or even that—as was pointedly connection with the two wine samples mentioned at the g of this discussion—such wine is "not wine at all." This o extremes not warranted by the facts of the case, and can ken the position of those who are in favor of honesty in ing as well as in all else. The objection can be broadly, ny view very strongly formulated thus: The use of glucose o gross abuse, leading to actual fraud wherever permitted; justified in countries where without it there may be total entire vintages; in California there is notoriously no such ce the use of glucose can here serve only the purpose of nt dilution, thus casting a shadow over the reputation of a wines in general, which the wine-growers cannot afford in t of view.

say those who would like to take advantage of the reputablished for California wines by their more conscientious s, "chemists admit their inability to detect the addition of pe sugar to must; so there is no danger of detection." Leav- the question of morality, those making the assertion lean ken reed. It is true that an addition of PURE grape sugar t be detected save by a comparison with a pure wine made same grape. But *pure* grape sugar is practically unattainae wine-maker. What is commercially called glucose coneater or less percentage of true grape sugar, varying from ninety-five, or sometimes even more per cent. But the subccompanying the glucose are little or not at all changed by tion, and can be in almost all cases detected by close exam- Such was the case in one of the samples sent by Mr. Pellet. oportion between the several ingredients, quantitatively ed, is obvious on inspection of the subjoined table. Thus, residue in sample No. 30 (No. 2 of Mr. Pellet) is fifty per her than in the pure wine, No. 29, (No. 1); the same is true

of the ash; the total acid is in excess of No. 1, while
amount of *tartaric* acid shown is absurdly low in No. 2
while no sugar is indicated by the polarization test, the c
for sugar shows clearly the presence of a substance not e
natural wines.

Comparative Analyses of Pure and "Chaptalized" Wine, from

	No. 29 (1)	No. 30 (2)
Total Sugar by Copper test, per cent	0	.89
Sugar by Polarization	0	0
Tartaric Acid and Malic Acid, per cent	.1295	.066
Bitartrate of Potassium and Malic Acid, per cent	.1128	.084
Acid calculated as Tartaric Acid, per cent	.2750	.330
Alcohol, weight, per cent	10.1800	10.920
Alcohol, volume, per cent	12.6000	13.500
Organic matter, per cent	1.8660	3.01
Ash, per cent	.2412	.344
Residue by evaporation, per cent	2.1070	3.358
Residue by Spindle, per cent	1.6420	2.892
Specific gravity of dealcoholized wine, per cent	1.0070	1.012
Specific gravity	.9900	1.000

Even the poor consolation of security from detection, ther
the users of glucose in wine. It may not be within the pow
one who calls himself a chemist to go into the minute ex
often required, the more as glucose from different sources
ferent in its behavior and manifestation; but an expert ch
rarely fail in the detection of the use of *commercial* gluco
case before us, adulteration had been so clumsily made as t
ent at the first taste of the compound. Better results ca
be secured with the use of a more intimate knowledge and
ment; but when these are acquired, it will even *pay* bette
them to a better purpose, viz.: the production of the bes

ıe, from the excellent raw materials supplied by the vineyards apa Valley.

osition taken by the St. Helena Viticultural Club is, in my ıinently sound from every standpoint, and it is to be hoped er associations will follow the example promptly and ener-, and thus maintain, unimpaired, the fair name of California.

ORT OF WORK, WITH TABLES, DIAGRAMS, AND DISCUSSIONS.

BY F. W. MORSE.

MEANS AND APPLIANCES.

g the first part of our work we necessarily labored under sadvantage in not having the proper appliances at our dis-A large amount of the crushing and stemming of grapes was hand, without the use of crusher or stemmer, thus consum-reat deal of time, and delaying analyses that should have ne as soon as possible after taking the grapes in hand. With ese difficulties were removed, and now we are supplied with us sufficient for all of our present needs.

temmer, consisting of a small, wooden frame, twenty-four ong by eighteen inches wide, supporting a sieve made of rass wire, which forms meshes of one half an inch by three serves admirably for the small quantity of grapes we have to

rapes are crushed between two seven-inch redwood rollers so frame that the whole apparatus can be placed over the fer-tubs which are to receive the crushed grapes.

ress is not all that could be desired if we wished to extract test amount of must from the grapes; but by repeated press-stirring up of the pomace we are enabled to get a larger of juice than the average wine-maker with his more power-sing. It is a medium sized cider press.

ermenting tubs for red wines are made out of large whisky by sawing them in two in the middle, and supplying each 'swimmer" cover, sufficiently tight to prevent an excessive of air to the fermenting mass. Small weights are used to the pressure during violent fermentation. The greater part ermenting is done in five-gallon boxed demijohns.

cellar has been dug in the hillside falling off toward Straw-reek, near the 'South Hall' of the University. The walls are, 20x46 feet, and the clear height eight feet; on the upper side sufficiently above ground to give room for transom windows, the side toward the creek, all but the foundation is above and a large double door forms the main entrance. This ccess to a passage seven feet wide, which divides the cellar

into two nearly equal parts, by brick partitions. This division is for the purpose of being able to use a different temperature in each, as may be necessary. The transom windows have double sash, to guard against outside changes of temperature, and two ventilators are placed in each compartment. Both have floors laid in cement, so sloped as to drain any water that may be used on the inside, or enter from the outside; but the latter contingency is provided against by a filling-in of rubble, between the walls and the hill, and drains laid in the foundation. The whole is covered by a wooden building, which was moved upon it from its former site, higher up. It is partly occupied as a carpenter shop; a room 20x11 feet, at its eastern end, has been fitted up as a viticultural laboratory, which communicates with the corresponding compartment of the cellar by a trap-door and stairs. It is properly fitted up with work tables, shelves, closets, sink, a stove with steam bath, also serviceable for heating a moderately large iron kettle; a saccharometer, alcoholometers, a number of thermometers; a small still for determining the strength of wines, etc.; and such other appliances as are needed in an analytical laboratory, as, also, gas and water. The cellar compartment underneath is, moreover, provided with a small stove, for the maintenance of the proper temperature. The whole building is so well protected and shaded by trees that the latter point is rendered comparatively easy to guard."

MODE OF OPERATING.

Passing from the apparatus to the mode of operating, it may be described as follows: We have tried as far as practicable to make two samples of wine from each variety of grape. For this purpose the grapes were divided into two parts—one for fermenting on the skins, the other to be pressed before fermenting; the former to be designated as "red" wine, the latter as "white." The total weight of grapes is taken, the per cent of wet pomace and stems is determined, besides an after determination of air-dried pomace. As soon as possible after the pressing of the grape, and before any change has taken place in the must, a determination of specific gravity, sugar, acid, etc., is made, as will be seen further on.

The must for the white wine, after the pressing, is transferred to a five and a two-gallon demijohn, in which the fermentation is to take place. It is allowed to ferment in these vessels until the violent fermentation is over and the lees have begun to settle. It is then transferred or "racked" into fresh demijohns to remain until clear, or until circumstances require it to be racked again.

The "red" wine, fermenting in the tubs, is left until the sugar is nearly all changed, the fermentation subsiding, and the largest amount of color is obtained; taking into consideration in the meantime the general behavior of the fermenting mass with regard to acetification, rapid fermentation, etc., all of which may lengthen or shorten the time before pressing. After pressing the murk an acid determination made of it is next placed in a demijohn, to be treated in the same manner as the white wine.

METHODS OF WINE ANALYSIS.

Much confusion often arises in the interpretation of results of

analysis when the methods are not fully understood. The following is a short synopsis of the different methods used during the whole work: First, by the usual process of separation and weighings, we have the proportion of stems, pomace, and juice determined. The pomace is afterward dried over a water bath at a temperature of about 45° (C.) until the weight remains nearly constant. The number of gallons of must is calculated from the weight, by means of the specific gravity test, at the time the juice is extracted, or when the red wine is pressed from its pomace.

Specific gravity.—A common hydrometer is used for this purpose; the temperature of the solution is noted at the same time, and proper corrections made for any change in temperature from the standard which I have taken at 17.5° (C.). By referring to the table of specific gravities of sugar solutions we obtain, approximately, the percentage of solid contents. The must contains so much saccharine matter that it may be considered as a pure sugar solution, no sensible error resulting from the other matter that may be present. As a check upon the preceding method, a measured portion, twenty-five cubic centimetres, or preferably ten, is evaporated and dried at 100° (C.), until a constant weight is obtained. Considerable difficulty is met with in reaching the point where all the water has been driven off and still no decomposition of the residue has taken place. The dry residue thus obtained is charred, and the soluble salts extracted with distilled water, after which the organic matter is burned out at a dull red heat. The total ash, soluble and insoluble, is thus determined. The organic matter is calculated by difference.

Sugar.—Two kinds of sugar, in varying proportions, are present in all grape juices; viz., fruit and grape sugar. In order to make a determination of both kinds we have to resort to a combination of two methods; viz., polarization and the copper test. In the latter test a definite amount of an alkaline copper (Fehling's) solution is reduced by the sugar, and the total sugar of both kinds is determined. To determine the per cent of each kind the clarified must is placed in the polarizing saccharometer. If the polarization be to the left we have a greater polarization by fruit sugar than by grape sugar, and the amount of sugar producing this excess of polarization must first be determined. Not having any data by which we can determine directly the per cent of fruit sugar from the single reading of the saccharometer, it becomes necessary to obtain by calculation the quantity of sugar corresponding to one degree indicated by polarization. In the instrument used one degree of rotation to the right requires, in one hundred cubic centimeters, .165 grams of cane sugar.

If, now, we have two standard sugar solutions, each containing the same amount, one of fruit, the other of cane sugar, it will be found that their rotating power will be in the proportion of 31.8 to 20. Hence, for every degree of rotation caused by fruit sugar there will be .629 of a degree rotation of cane sugar, or in the proportion of one to .629. If this constant (.629) be multiplied by the above constant of .165, we will find the number of grams of fruit sugar required to produce one degree of rotation, which is .1037. This enables us to estimate the amount of fruit sugar that gives us the observed degrees of rotation. Deducting this amount from the total sugar by the copper test, there is left the fruit and grape sugar, whose opposite rotations, in certain quantities, neutralize each other. To determine the proportions of each we must use their molecular rotating coefficients. The

molecular rotating power of fruit sugar is one hu
degrees to the left; grape sugar, fifty-six degrees to t
relative quantities of sugar are inversely proportioned t
power. If one degree of rotation by fruit sugar is
given quantity of mixed sugar, it would require 1.893
to produce the same degree of rotation in the opposite
to neutralize the effect of rotation of each, it will req
of grape sugar to one part of fruit sugar; or, to plac
form, .345 parts of the remaining sugar is fruit, and
is grape sugar. Adding the fruit sugar obtained by
that which neutralized the grape sugar, we obtain
sugar, which, by difference, gives us the amount of gr

Acids.—As it is impossible to make a determination
different free acids known to be present, we have ma
minations only, and from this calculated all the acid
being considered the most prominent. We used for
one-tenth solution of standard caustic potash. The sta
contains .0561 grams of caustic potash per cubic centim
five cubic centimetres of must was used for a determina
the amount is increased to thirty. A solution of litm
an indicator.

Coming to the wine, the first determination made
cific gravity, which is done as in the must determinat

Alcohol is determined with M. J. Salleron's instrum
of a small still and condenser, one hundred cubic cent
each time and one half of its volume distilled over;
diluted to the original bulk of the wine and its s
determined by spindle alcoholometer. The volume
responding is found in the usual tables.

Dealcoholized Wine.—The solution remaining after t
been extracted from the wine is diluted to the origina
specific gravity taken. By this means we are enable
at once the solid contents of the wine, assuming, of
solid contents will give the same indications as a cor
cent of sugar solution. This supposition holds good
beer-wort without appreciable error, and will no dou
comparison in wine residues. It does not always giv
as there will be noticed a considerable difference be
contents as determined by this method and by evapo

Residue by Evaporation.—During the first year of o
twenty-five cubic centimetres of liquid was used fo
determination; these results generally were too high,
case of the wines, while with the musts less difference
Since using ten cubic centimetres the results have fa
below the amount indicated by the specific gravity
difference is explained by the loss of constituents that
off during the distillation of alcohol, but are vola
(C.). Glycerine is chief among the constituents thus
amount in a highly alcoholic wine, reaching as high
and upwards. Whether this is all volatile at 100° (
evaporation, is still doubtful, but from the regularity
of the classes of wines analyzed, in which we would
amount of glycerine, we cannot but come to the c
nearly if not quite all is driven off. As a rough tes
.2388 grams of glycerine and dried it under the sa

as near as possible, along with a wine residue. At the end of the seventh day it had nearly all disappeared, showing that if there be glycerine present it will be lost during the drying. The average time of drying between weighings was about six hours. This is a longer interval than is generally adopted, but I think it better to use longer intervals and let the limit of difference between the last two weighings be greater. Instead of stopping at the end of two or three days' drying, I have continued until I reached a point at which there is no further loss; this in some cases has required twenty-five days.

Bitartrate of Potassium and actual Tartaric Acid.—A measured portion of wine is treated with about five times its bulk of alcohol and ether, or strong alcohol, and allowed to stand two to three days while the bitartrate crystallizes out. The crystals are collected, redissolved, and titrated with alkali solution and the per cent of bitartrate calculated.

The actual tartaric acid is similarly treated after neutralizing one fifth of the free acid with potash. In both cases the malic acid is precipitated and calculated as tartaric acid or bitartrate. The malic acid has been determined in some of the wines by dissolving in a small amount of water the malates which are precipitated with the tartrates during the tartrate determination and titrating them separately.

Tannin.—A quantitative estimation of this substance is not easily accomplished and is quite unsatisfactory. A few of the red wines were tested quantitatively by means of a standard gelatin solution. The standard solution is prepared by dissolving pure gelatine in water, and ascertaining its strength by titrating it with a definite quantity of standard tannin solution. Having the strength of the gelatine solution, it is only necessary to treat a measured quantity of wine with it until a precipitate is no longer formed. It is difficult to fix the exact point so that an excess may be avoided; this can be done only by repeated trials. From the volume of gelatine solution required it is easy to calculate the per cent of tannin.

The amount of tannin in white wines is too small to be estimated quantitatively by the preceding method. Its relative amount is shown by the change in color produced by a drop of chloride of iron added to the wine, after the acid of the wine has been neutralized by an excess of carbonate of soda.

Coloring Matter.—The amount of natural coloring matter was determined in three of the wines, as shown in the table, but the method is very long and the importance of the analysis would not warrant us in applying it to all the red wines. Several tests were made in some of the contributed wines for foreign coloring matters, but all were found to be free from extraneous colors.

FERMENTATION OF THE WINES.

Temperature.—An even temperature is one of the first requisites of good wine-making. Too little attention is paid to it by the average wine-maker, who thinks he is interested only in getting the fermentation started and then lets it take its course, be it very violent or at intervals almost stopped; no adequate provisions are usually made for the regulation of the temperature of the fermenting room. Much depends upon the mass of the fermenting liquid. In our case it is quite

impossible to keep exactly the desired temperature, as the quantities we are compelled to use are so small that the slightest change in the room soon produces a perceptible effect on the wines; we have, therefore, been forced to rely upon artificial means, and have, to a certain extent, been successful. The room was kept between 60° and 65° (F.) during the most violent fermentation, and, as the fermentation ceased, the artificial heat was lowered to the natural temperature of the cellar.

Our heating apparatus was not ready when we began wine-making in 1880, so we were compelled to use the upper room for fermenting purposes, thus subjecting the musts to great variations in temperature until they were removed to the cellar. During the violent fermentation the temperature of each wine was taken three times a day, also that of the room.

As a full record of the observations would make too voluminous a table for publication, I have, in the following diagrams, constructed from the tables, represented graphically the rise and fall of the daily temperatures. On the horizontal lines are noted the dates of observation, and on the perpendicular lines the temperature in degrees (C.). The average temperature of each wine during the day is taken for the temperature observations, excepting on those days when the wine reaches its highest heat, then the highest observation for that day is recorded. The broken line represents the temperature of the cellar, morning observations alone being recorded.

The diagrams show a very variable time of active fermentation, ranging from three to fifteen days, with an average of about eight days; much depending upon the quantity of sugar to be changed and the regularity of the temperature of the room. If the fermentation begins under favorable temperature conditions it will pass through the critical point before the outside temperature will produce any notable effect upon it, unless such change be very great. The fermenting masses were not all at the same temperature when fermentation began, consequently, in some cases, the range or difference between the highest temperature and the starting temperature is very great. The range will not, therefore, give us any definite data regarding the amount of heat developed by the fermentation. The range varies from one to thirteen degrees centigrade.

The highest absolute temperature was twenty-seven degrees. This was reached during a very active and regular fermentation by two wines—the White Zinfandel of 1881, and the White Mataro of the same year.

In comparing the course of temperature in the white and red wines (see diagrams) it will be noticed that the white wines reach the highest temperature, remain the shortest time at this temperature, and are less affected by external changes in the room; also, that every change in the temperature of the white wine is promptly followed by a like change in the red, although less in degree. The line representing the course of changing temperature in the red wines, forms usually a sharp angle when the wine has reached its highest temperature, while the white wine usually forms a gradual curve. The difference becomes greater during the last part of the active fermentation, as the red wines, which are not so well fermented, are more subject to change at this period. The red wines remain some time at this elevated temperature before beginning to decrease, and continue at a reduced temperature, even when the fer-

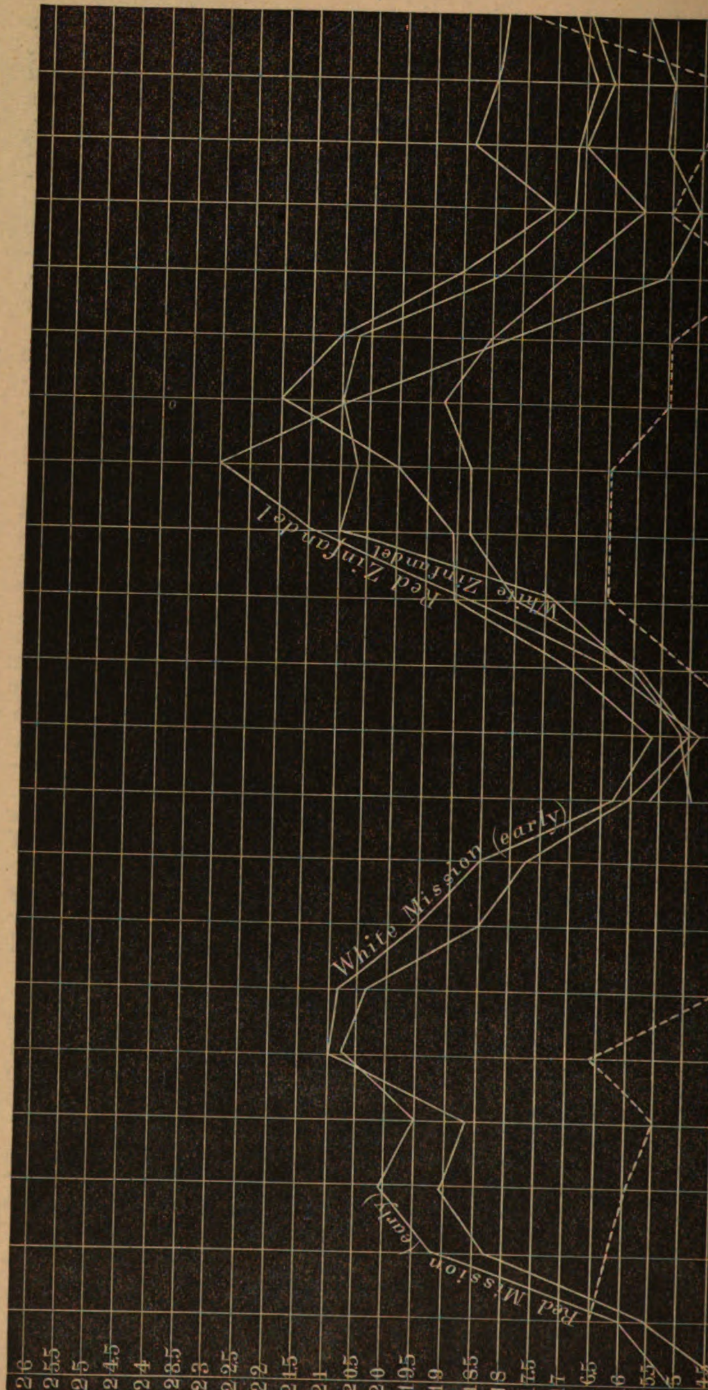
mentation is completed. The after-fermentation of the wine depends much upon the regularity of the first fermentation. If the first part, which is the most rapid and most subject to change, has been passed over without any disturbance of fermentation, the wine soon becomes quiet and is little affected by outside changes. When, on the contrary, the first two days of fermentation are accompanied by a falling of room temperature, the entire fermentation will be hindered and possibly stopped.

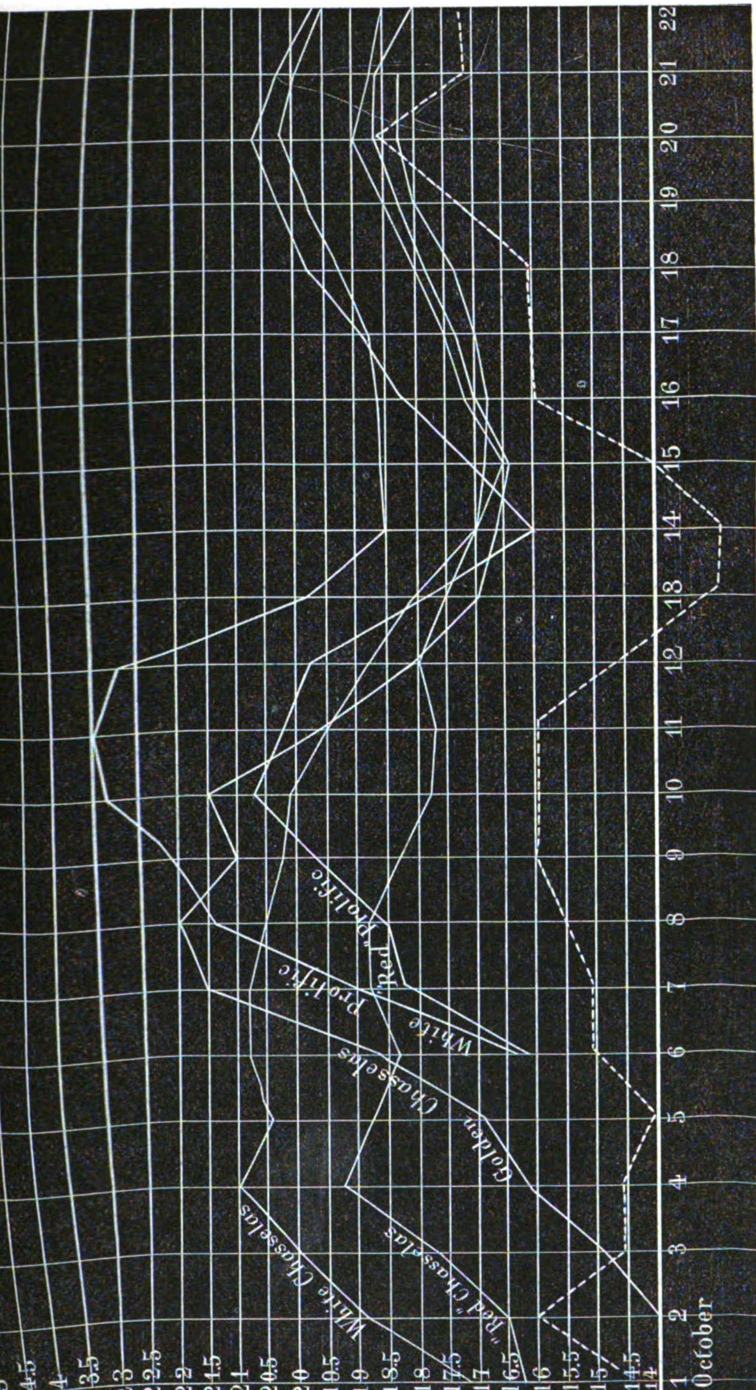
The first four days of active fermentation may then be said to be the critical period, and should be carefully watched if we wish fermenting action enough to carry it through the next stage. An active, regular, first fermentation insures an even temperature for the wine during the last stages.

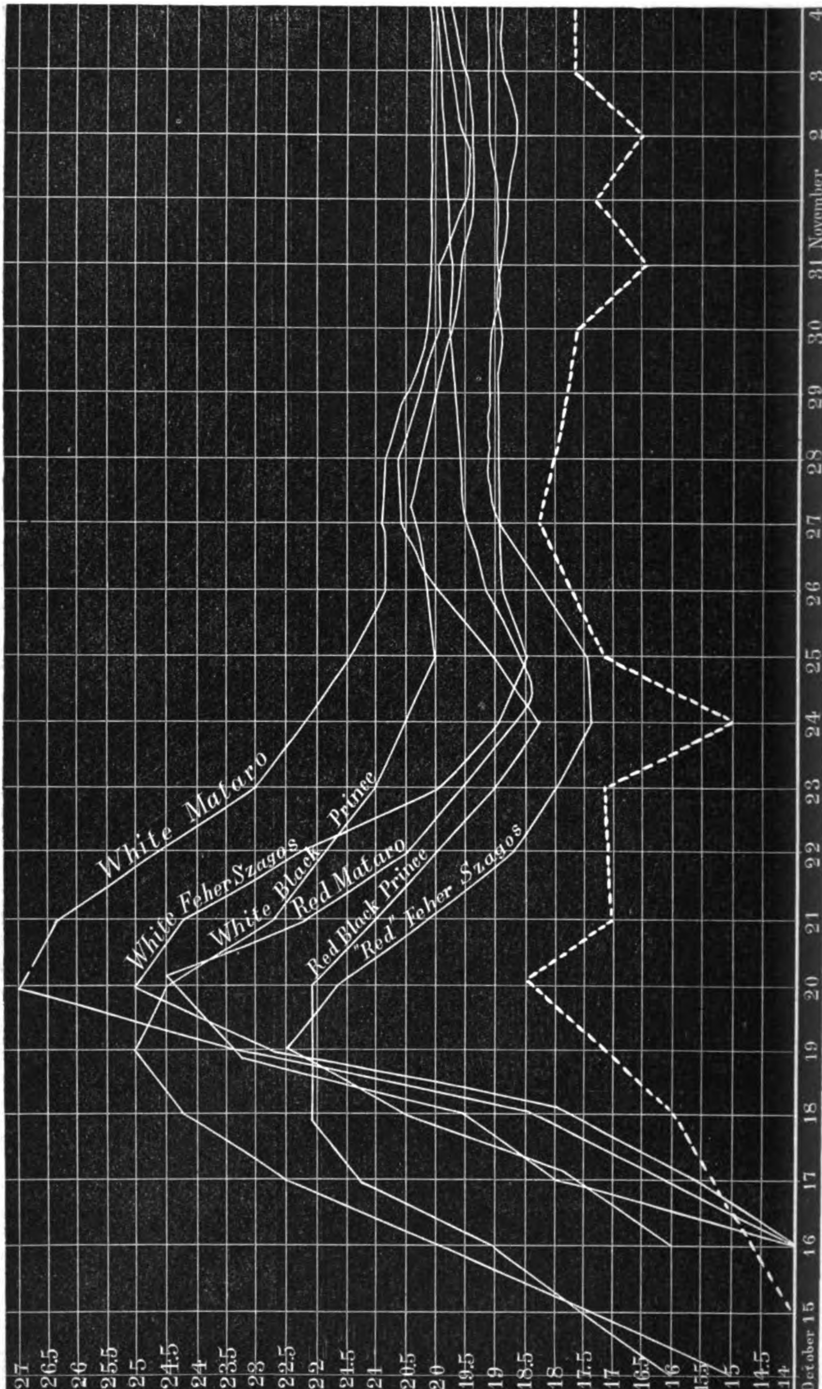
The effect of varying room temperature is clearly shown in the Malvoisie, Mission 1881, Burger, and others. The three wines mentioned each began with low and decreasing temperature of room, which soon checked the fermentation in the case of the red wines and nearly stopped their action; while the Mataro, Feher Szagos, and Black Prince, beginning under favorable circumstances, soon completed an active fermentation, and were no longer perceptibly affected by changing temperatures. During the first two or three days the room temperature produces its greatest effect; for a degree of heat added from the outside may so intensify the fermentation as to cause a rise to several times that extent in the fermenting mass. If it decreases sufficiently to lower materially the temperature of the wine, we may expect a slow or reduced fermentation during the remainder of the fermentation. If the fall in room temperature occurs after the fermentation has reached its maximum activity, the effect will scarcely be noticed by any sudden change in the wine. A notably large increase in temperature at this period has only prolonged the cooling of the wine, without increasing its temperature. The late Mission of 1881, instead of falling rapidly, decreased its temperature gradually for eight or nine days, under the influence of a gradually increasing room temperature. The temperature of the White Charbonneau and Burger *fell* when the room temperature was rapidly *rising*, while in the later fermentation of the Malvoisie only a slight deflection of the course of the curve was caused by a rapid increase of temperature.

The violence of the fermentation is not always truly indicated by the wine temperature. The Red Malvoisie, during the first two days of fermentation, fell three degrees in temperature and then began rising; still it passed through a very violent fermentation in the first five days. The Golden Chasselas reached a higher temperature but fermented less violently than the other Chasselas.

Six diagrams, showing the course of temperature in fermentation, were constructed, but only numbers one, two, and three are published, as these will represent the chief variations in temperature that the wines pass through during fermentation.


White Zinfandel
Red Zinfandel
White Mission (early)
Red Mission (early)
26
25.5
25
24.5
24
23.5
23
22.5
22
21.5
21
20.5
20
19.5
19
18.5
18
17.5
17
16.5
16
15.5
15


White Chasselas
Red " Chasselas
Golden
Chasselas
White
Prolific
Red "
Prolific
October
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
14
14.5
15
15.5
16
16.5
17
17.5
18
18.5
19
19.5
20
20.5
21
21.5
22
22.5
23
23.5
24
24.5



White Mataro
White Feher Szagos
White Black Prince
Red Mataro
Red Black Prince
"Red" Feher Szagos
27
26.5
26
25.5
25
24.5
24
23.5
23
22.5
22
21.5
21
20.5
20
19.5
19
18.5
18
17.5
17
16.5
16
15.5
15
14.5
14
October 15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31 November
2
3
4

OF THE BEHAVIOR OF THE DIFFERENT WINES IN FERMENTATION.

(See Diagrams 1, 2, and 3.)

on.—The early Mission of 1880, made from grapes barely ripe, ermenting under changing temperature of the room and fol- closely its rise and fall. A falling of one degree in the tem- e of the room produced a decided fall in the temperature of nes when they were passing through their most vigorous fer- ion. A sudden rise of one degree in room temperature was iately followed by a more decided rise in the wine tempera- it, unfortunately, at this point the room became very cold and nes were prevented from continuing their fermentation. At l of the fifth day this large decrease in temperature began, ntinued until, on the eighth day, it reached thirteen degrees; ys later the room was at its normal temperature and the wines assing through a second fermentation developing more heat uring the preceding stage. This is the only case in which a stage of fermentation has been at all successful. The late ns of the same year unfortunately began fermenting at a low emperature, which prevented an active beginning; they show reciable variation, such as might have been caused by the very e outside temperature, although no doubt they did not reach a point as they would have done under more favorable con- The fermentation of the white wine was violent, but the ature did not increase in proportion to the activity. At the the fourth day the room temperature was much reduced, and ed a very slow and regular decrease in wine temperature.
Mission of 1881, too, starts out with an extreme falling of emperature, which produces a decided effect upon the wines. l wine increases one and one half degrees the first day, and nd of the third day is back to its original temperature. With urn of the usual room temperature came a slight increase in nperature of the wine, which afterward followed closely the ons of the room. The white wine was much less affected dur- first four days; after this time the two wines varied alike both than the ordinary temperature, the white higher than the red. oth show plainly the effect of an interrupted first fermenta- d also show, that if once interrupted the remaining fermenta- ll be very quiet and prolonged and is apt to be incomplete. markable that in these three Missions, all fermenting under rable circumstances, the early Mission, carrying the smallest t of sugar and medium acid, should revive its fermentation oduce two distinct stages, each stage a complete course of fer- ion. The next in quantity of sugar and heaviest in acid, was tive in fermentation, and the remaining one, very *rich* in sugar, *st* violent.
bonneau.—Little can be said of the fermentation of these wines. ermentation began during a rise in room temperature, which high to excessive, although varying. The fermentation was d apparently not in the least affected by any external causes. hite wine increased only four degrees in temperature in four

oisie.—This variety ferments violently, but does not increase

proportionately in temperature. The temperature of the
low at the beginning of fermentation, but with this disadva
white wine reached its highest temperature at the end of t
day, and began descending. On the sixth day a decided ris
temperature occurred, and checked the falling temperatu
wine for two or three days, when it began falling again. T
of decreasing temperature was very extended and gradual.
this period, two decided rises in room temperature occurred
during the first part of the falling, produced the greatest eff
wine; the latter, which was the greater, produced only a sli
although the room temperature became somewhat higher
of the wine. The fermentation of this wine resembles som
Chasselas, although less prolonged and decidedly more act

Zinfandel.—Ferments quite rapidly with considerable in
temperature, and shows a greater difference in temperatu
Zinfandel of 1881 than those of the other wines of the sa
The first stage of fermentation is very rapid, and the wine
quickly in temperature. The white wine of 1881 incr
degrees on the second day of fermentation. The falling ter
is correspondingly rapid, lasting from three to four days, le
wine at a low temperature and no longer subject to cha
action seems to be complete. The Zinfandels of 1880 passe
a peculiar fermentation. The red wine, contrary to the u
rose rapidly to its highest point, began descending immedi
more rapidly than it rose. It closely follows the course of
white wine. The white Zinfandel serves as an excellent ex
interrupted fermentation. It follows the natural course
third day, when it stops increasing in temperature and ren
stant for three days, then descends quickly for two days, an
a somewhat high temperature completes its fermentation
curve representing the change in temperatures be construct
ing the course that the wine temperature no doubt would ha
had not the interruption occurred, it would have shown a ris
degrees, and fallen to a lower temperature when violent acti
The temperature of the room was favorable until the wines h
the critical point.

Burger.—These wines present a peculiar unconformity to
rule. Their fermentation is short and very quiet, resemb
siderably the Charbonneau. On the second day the temp
the white wine rises slowly, while the "red" wine falls. D
first four days the greatest difference in temperature of t
wine was only two degrees, and the first fermentation was
with less than one degree's increase in temperature. At t
the fourth day the wine had reached the highest point of a s
mentation, and began falling until, on the seventh day, it wa
thirteen degrees—two degrees below the prevailing room tem
The wine was above the lowest limit of proper fermenting
ture only six days, still, its fermentation was complete, as
the amount of alcohol produced. The white wine seemed le
by the changing temperature, and passed fairly through its
tion. The room temperature during the time was very var
never below the limits of proper fermentation until the act
wine had ceased.

Chasselas de Fontainebleau.—In this variety we have a
shows no rapid changes in temperature, but is noticeab

prolonged fermentation at its highest temperature, and the very gradual falling when the fermentation ceases. The fermentation begins slowly, rises two or three degrees, and continues with slow action. The white wine fell only one degree from its maximum height in six days, and the "red" wine fell the same in five days; during eleven days the former wine fell only four and one half degrees, while the latter fell less than three. The temperature of the room, in the meantime, was quite constant; it was low only three days.

The *Golden Chasselas* has a more marked temperature-change than the preceding, still the fermentation was not so violent, and was slow to start. It began at the low temperature of fourteen degrees, and was five days in rising to twenty-one and a half; here it remained for three days, varying only half a degree from this point. It fell with the same slow rate at which it had risen. The highest fermenting temperature was reached on the sixth day, but the most violent action was not reached until two days later.

Prolific or Sauvignon.—These wines have an action similar to the Chasselas, and would, no doubt, have been represented by a similar curve if the temperature-conditions had been the same. Their first fermentation was slow, but exceeded that of the Chasselas; both increased slowly in temperature just before reaching the maximum height, and both remained some time at this temperature before beginning to fall. The fall was increased by the rapid and extended falling of the room temperature, which preceded the change in the wine by one day. This is proven by the slight after-fermentation that follows when the usual room temperature is restored. The "red" wine was most affected, as its fall is lower, and when it rises it rises higher than the white wine, although both indicate a continued fermentation by their high temperature. This accounts for the sugar remaining in the white wine, and shows, at the same time, that the fermentation of this class of wines, although apparently but little affected by change in room temperature, are in reality much affected by such changes. It also shows that it is a wine which, when once checked in fermentation, will be hard to start again. Want of albuminous matter, as will be shown further on, undoubtedly assists in producing this slow fermentation.

Mataro, Feher Szagos, and Black Prince.—These three wines, taken together, had an excellent fermentation. They show a wide range in temperature and a complete action. The White Mataro is remarkable for having passed through thirteen degrees of temperature in four days, starting at the lowest point and rising as high as any of the other wines. The last part of its after-fermentation is somewhat more prolonged than the other wines. The *Feher Szagos* presents no peculiarity, and is a medium active wine in fermenting. The *Black Prince* was quite active during fermentation, especially the white wine. Its curve resembles slightly the Chasselas or Prolific, changing slowly at the highest temperature, followed by a moderate rate of decrease during its later stages. The red wine remained two days at its highest temperature, and afterwards passed through a slight second fermentation. Thirteen days after the fermentations began the wines were all quiet; eight days from this time their temperatures were nearly the same, but they were regularly arranged so that the two Mataros were together with the highest temperature, the two Black Prince wines next, followed by the Feher Szagos.

SUMMARY RECORD OF GRAPES WORKED AND WINES MADE IN 1880 AND 1881.

1. *Wines made in 1880.*

It seemed desirable to make at least one comparison between the wines from grapes just ripe and that of the same variety when allowed to remain on the vine until the greatest amount of sugar is produced. For this purpose the Mission variety was selected, its high per cent of sugar rendering it specially adapted for the test. A specimen was accordingly sent by Dr. J. Strentzel, of Martinez, Contra Costa County. The grapes were received in good condition, just ripe, October tenth, crushed October twelfth, and made into the wines designated as Nos. 1 and 2.

No. 1—White wine. The fermentation began slowly October fourteenth, and continued until the wine was racked, November twenty-sixth, the most violent action having finished by the seventh day. The wine was clear and bright June third.

No. 2—Red wine. Fermentation began October fourteenth, and continued in the fermenting tub until October twenty-third, when it was pressed; racked from the lees November twenty-sixth. The fermentation was moderate to slow throughout. February second the wine was quite clear, but did not become bright until June third.

Nos. 3 and 4 are Mission wines made from fully ripe grapes taken from the same vineyard as Nos. 1 and 2. The grapes were received November tenth, in very good condition, but not over-ripe as was desired.

No. 3—White wine. Fermentation began November twelfth and became very violent on the fifth day. It was racked December fifteenth and was clear June third; racked again November sixth.

No. 4—Red wine. Fermentation began November twelfth, violent; pressed November twenty-second, when a large amount of tartar had precipitated; racked December fifteenth; June third the wine was clear but not bright; racked again November eighth, when a large amount of tartar had separated out.

Nos. 5 and 6.—Zinfandel wines made from grapes sent by Mr. Chas. Krug, St. Helena, October twenty-second. The grapes were over-ripe and quite soft.

No. 5—White wine. Fermentation began October twenty-third and reached its most violent action in about five days; racked November twenty-ninth and was clear April thirtieth; racked again November third.

No. 6—Red wine. Fermentation began October twenty-third; pressed October thirty-first, and racked November twenty-ninth. The wine does not clear readily, and about July seventh had a tendency to turning and continued failing, similiar to Charbonneau. It was again racked November third, when considerable tartar had been deposited.

Nos. 7 and 8 are Black Malvoisie wines, from grapes sent by Mr. Charles Krug, October twenty-eighth.

No. 7—White wine. Fermentation began October twenty-ninth, and continued very violently until the fifth day. The wine was racked December ninth; clears very slowly; June third still turbid.

No. 8—Red wine. Fermentation began October twenty-ninth; continued violently five days; was pressed November eighth, and racked December ninth; remains slightly turbid; June third, slightly turbid.

Nos. 9 and 10 are Charbonneau wines, from grapes sent by General Naglee, San José, October thirtieth. The grapes were packed in barrels, and were very badly crushed and damaged before reaching us. Scarcely enough grapes could be taken from the lot to make the white wine; those used were scarcely fit for the purpose.

No. 9—White wine. Began a moderate fermentation November first; racked November twenty-eighth; molds very readily; does not clear, and has a strong tendency to acetous fermentation; June third, almost bright; racked, August twenty-second.

No. 10—Red wine. Began fermenting November first; proceeded slowly with only slight increase of temperature until pressed, November eleventh, when the fermentation was quite complete; racked November twenty-eighth; has a tendency to acetous fermentation; molds easily, and in May, shows signs of turning; does not clear well.

Nos. 11 and 12 are Burger wines, from grapes sent by Mr. Charles Krug, St. Helena, November fourth. The grapes were in a very poor condition; some had already soured and molded, and could not be used.

No. 11—Wine fermented without skins. Fermentation began November fourth; racked November twenty-eighth; June third, wine was quite clear; on August twenty-second had signs of failing but was immediately racked, when it became clear and bright again.

No. 12—Grapes fermented with skins. The fermentation began November fourth, and continued but a very short time; at the end of two days began to subside; the fermented grapes were pressed November thirteenth, and the wine racked November twenty-eighth; began to get moldy in the middle of April, and on the seventh of May showed signs of turning; June third, turbid; August twenty-second, drawn from the residues.

2. Wines made in 1881.

Nos. 13 and 14—Chasselas de Fontainebleau, sent by Mr. J. Gundlach, Sonoma, September twenty-seventh. The grapes were in excellent condition, and fully ripe.

No. 13—Wine fermented without the skins. Fermentation began October first, and was quite violent on the second of October; slight fermentation on November tenth; was racked November twelfth; November twenty-first, has a tendency to formation of mold; racked again on the twenty-first of April; June second, nearly clear.

No. 14—Wine fermented on the skins. Fermentation began slowly on the first of October, and continued quietly until the eighth; still had a sweet taste; pressed October tenth; November tenth the fermentation is imperceptible, and on November eleventh racked; on the twentieth of April racked, leaving a yeasty sediment which was quite abundant; June second, wine is clear and bright.

No. 15—Wine from Golden Chasselas grapes sent by Mr. Charles Krug, St. Helena, October first. They were all fermented on the skins, as they came in such poor condition that white wine could not be made from them. They began fermenting October first, and continued very slowly for the first seven days; on the tenth day it reached its highest point, and began subsiding; pressed October twelfth; November tenth the fermentation was very slight; racked November seventeenth.

Nos. 16 and 17—Prolific or Sauvignon wines, made from grapes

..., and again on April twenty-seventh; slight depo
since the last racking.

Nos. 22 and 23—Wines from Black Prince grape, sent
West, October thirteenth. The grapes were very ripe
were so dry that no juice could be extracted from them;
the fermentation on the skins the dried grapes were bu
affected.

No. 22—White wine. Began fermenting October
November tenth fermentation quite strong; November
not perceptible. The wine was racked December fou
April twenty-seventh; July fifth, wine was clear but not

No. 23—Red wine. Began fermenting October four
pressed October twenty-fourth, and racked on Decembe

il twenty-sixth. The fermentation was slight November
l not perceptible November twenty-first.
and 25—Feher Szagos wines, from grapes sent by Mr. G.
esno. The grapes were in very good condition.
—White wine. Fermentation began October sixteenth; No-
tenth very slight; racked November eleventh and again
nty-second. Considerable tartar was deposited between the
second racking. The wine has a strong tendency to acetifi-
d formation of mold; remains turbid.
—Wine fermented on the skins. Fermentation began Octo-
enth; pressed October twenty-fourth; racked November
and again April twenty-second. A considerable yeasty
as left from the last racking. Like the preceding, it acetifies
ls easily and continues slightly turbid.
and 27—Mataro wines, from grapes sent by Mr. Charles
San José, October fifteenth.
—White wine. Began fermenting October sixteenth, and
nished by November tenth. Wine was racked November
inth and again April twenty-first. The amount of remain-
rom the latter was small, but the incrustation of bitartrate
y.
—Red wine. Began fermenting October sixteenth; pressed
twenty-fourth; racked November twenty-ninth and April
rst. Considerable amount of lees remained. The first fer-
n had nearly ceased by the tenth of November.
—Red Lenoir wine, from grapes sent by Mr. H. W. Crabb,
October eleventh. Only a small amount of grapes were
these were all made into red wine. The fermentation began
ifteenth; pressed October twenty-fourth; racked November
and again April twenty-sixth. The deposit of tartar was
e.

ANALYSES OF MUSTS.

le I is given a summary of the analyses of musts made dur-
o seasons. In this table is given, in addition to the analysis
ice, the per cent of pomace and stems and the quantity of
duced. The pomace was weighed in the wet condition, just
aken from the press. The percentage varies largely, accord-
different kinds of grapes, amounting in some cases to nearly
of the weight of the grapes. The pressure exerted was about
on each different variety.
ther column is given the per cent of air-dried pomace, which
inly the true amount of unused matter in the pomace.
d wines, of course, produce very much less pomace, which
argely of skins and seeds only. The white pomace has much
he pulp of the grape, and consequently a larger amount of
)uring the fermentation the internal structure of the grape
ed, the sugar is fermented out, and only the fibrous struc-
ains; even this is, to a great extent, broken up and runs out
wine when pressed.
roduction of wine per ton of grapes" is calculated from the
f must of the white wines and from the amount of partially
d juice of the red wines, produced from the weighed grapes.
wance is made for loss by escape of carbonic acid and depo-
residues.

calculation, slightly in excess of the evaporated residue. In the other cases it gives us a small difference, which is in accordance with the small amount of acid present.

It is of importance to consider which method of determination is most to be relied upon. I am inclined to think that the calculation based upon the amount of alcohol produced in fer-

Mission, just ripe
Mission, fully ripe
Mission
Zinfandel
Zinfandel
Malvoisie
Charbonneau
Burger
Chasselas
Golden Chasselas
Prolific
Black Prince
Feher Szagos
Mataro
Lenoir

same change; although their fermentation was regular but prolonged it need not necessarily have become *acetified.* The Black Prince and Mataro are examples of a similar change during an excel-

bouquet, faint; acid, pleasant, sufficient; astringency, qu
ble; body, light; alcoholic strength, medium; very imm

White Zinfandel.—Color, faint reddish topaz; condi
flavor, not decided; bouquet, not decided; acid, moder
astringency, scarcely notable; body, medium; alcoho
moderate, somewhat greater than the red wine; the wi
factory and poor, considering its age.

Red Zinfandel.—Color, purple; condition, bright; bou
claret; acid, decided, pleasant, somewhat sharp; astringe
body, medium heavy; alcoholic strength, moderate.

White Charbonneau.—Color, white, faint reddish; con
flavor, vinous; bouquet, decided, agreeable; acid, some
ive; astringency, scarcely perceptible; body, light, heav
Burger; alcoholic strength, low.

Red Charbonneau.—Color, garnet, inadequate; condition, clear; flavor, vinous; bouquet, decided, pleasant; acid, high; astringency, decided; body, light; alcoholic strength, low; well matured for its age. This wine cleared slowly at first, and showed signs of spoiling. To check this decay one half was treated with albumen solution. The wine thus treated had a rather light-garnet color, handsome but inadequate; condition, bright; bouquet, fainter than that of the wine not treated; acid, not so pleasant, yet decided, and rather excessive; body, very light. The wine, as a whole, is undrinkable.

Burger (without skins).—Color, white; condition, bright; flavor, vinous; bouquet, faint, agreeable; acid, decidedly excessive; body, light; alcoholic strength, low.

Burger (with skins).—Color, white; condition, clear, not bright; bouquet, not strong, but more decided than in the white; acid, decided, somewhat excessive; astringency, imperceptible; body, light; alcoholic strength, low, more perceptible than in the white.

White Malvoisie.—Color, light reddish brown; condition, clear, not bright; flavor, vinous, faintly nutty, seems adapted for sherry; bouquet, faint but pleasant, not very decided; acid, light, agreeable; body, heavy; alcoholic strength, high.

Red Malvoisie.—Color, purple red, deficient; condition, bright; flavor, vinous, faintly nutty; bouquet, not decided; acid, moderate, pleasant; astringency, slight; body, heavy; alcoholic strength, high.

Wines made in 1881.

These wines were all tasted in December, 1882, except the Lenoir and White Mataro, which were tasted in February and March, respectively.

White Chasselas.—Color, light topaz; condition, bright; flavor, nutty and vinous; Chasselas flavor strong; bouquet, decided, very agreeable; acid, adequate, pleasant; astringency, very slight; body, rather heavy; alcoholic strength, high. The wine is remarkably well matured for its age.

"Red" Chasselas.—Color, yellowish topaz; condition, somewhat turbid; bouquet, rather faint; acid, decided, somewhat excessive; astringency, decided; body, medium; alcoholic strength, low; Chasselas flavor faint.

Golden Chasselas.—Color, light topaz; condition, clear, not bright; bouquet, undeveloped, promising; acid, pleasant, decided; astringency, slight but adequate; body, medium; Chasselas after-taste, decided.

White Prolific.—Color, amber; condition, clear; taste, vinous; bouquet, decided, agreeable, somewhat alcoholic; taste, vinous, somewhat sweet, sulphurous twang; acid, rather low, agreeable; astringency, imperceptible; body, good; alcoholic strength, high.

"Red" Prolific.—Color, amber; condition, clear; flavor, nutty, less sulphurous than the white; bouquet, decided, pleasant, a little alcoholic; acid, rather low; astringency, very decided; body, heavy; alcoholic strength very high.

White Zinfandel.—Color, Brazilian topaz, somewhat reddish; condition, clear; flavor, vinous and decidedly nutty; bouquet, undeveloped, pleasant; acid, decided, agreeable; astringency, decided; body, considerable; alcoholic strength, high.

White Mission.—Color, white to pale topaz; condition, somewhat turbid; flavor, somewhat nutty; odor, vinous; bouquet, not

definite; acid, quite decided, somewhat pungent; astri noticeable; alcoholic strength, high; taste, decidedly sw

Red Mission.—Color, light garnet; condition, brig vinous, fair; odor, apparently a little sulphurous; bou acid, agreeable; astringency, fair; alcoholic strength, faintly sweet.

White Black Prince.—Color, Brazilian topaz; flavor, ous; bouquet, faint; acid, adequate, much covered astringency, perceptible; body, light; alcoholic stre excessive.

Red Black Prince.—Color, light garnet; condition, cl vinous, somewhat nutty; bouquet, more decided th white wine, partly covered by sulphur; acid, pleasan more decided than in the white; body, medium; alcohol high.

White Feher Szagos.—Color, white, faint topaz; condi almost bright; flavor, vinous, nutty; bouquet, faint, acid, decided, pleasant; astringency, scarcely percepti medium heavy; alcoholic strength, high. Rather promis

"*Red*" *Feher Szagos.*—Straw color; condition, slight flavor, nutty, more decided than the white; bouquet, c a sulphurous (?) twang; acid, decided, sharp; astringenc body, heavy; alcoholic strength, high.

White Mataro.—Color, reddish, between topaz and garn tion, clear; flavor, nutty, agreeable; bouquet, decided, plea decided, pleasant; astringency, decided; body, medium; strength, high.

Red Mataro.—Color, purplish garnet; condition, brigh nutty, not so decided as in the white; bouquet, decided cl pleasant; astringency, decided; body, good; alcoholic stren It was also tasted in February, at which time it had a pu color, fairly deep, clear; light body; decided astringency; acid; faintly musky flavor, with touch of mold; good strength; faint, undeveloped bouquet. Diluted (1–1), gi color; perceptible astringency, and faint acid.

Lenoir.—Color, extremely dark red; flavor, vinous, mol decided, almost pungent; astringency, low, inadequate; b heavy; alcoholic strength, low, inadequate. The wine whe with equal parts of water gives a very intense color, pleas and no flavor except moldy.

DESCRIPTIVE LIST OF CONTRIBUTED WINES.

The following list comprises those wines sent to us in res a circular addressed to a few of the vine-growers of each The circular was issued for the purpose of obtaining from th ent districts samples of wine made from the leading grape that are produced with the greatest success, and seem the mo ising for the locality. The call was very generously respond a few, but some of the main districts still remain unrepr Information regarding the nature of the soil, properties of t and peculiarities of fermentation, as far as could be obtained, with each sample of wine.

Table IV shows the results of the analyses of these wi jointly with those obtained from the wines made in our lab also, some analyses of representative European wines—not nu

No. 35—Red Zinfandel wine from Gundlach & Co., through Professor Hilgard, December 2, 1881. The color of the wine is full, clear; flavor, full; quality, fair; acid, rather excessive, hardly pleasant on dilution; astringency, medium, pleasant; body, full claret; alcoholic strength, high. Tasted December, 1881.

No. 36—Red Zinfandel, sent by Mr. I. De Turk, Santa Rosa, December 24, 1881; vintage, 1879; wine is bright; color, purplish red, moderately heavy; odor, claret characteristic, well ripened; taste, "California" taste moderate, scarcely perceived, especially on dilution; bouquet, good, moderate in quantity; acid, moderate and pleasant, dilutes remarkably pleasant; body, medium; alcoholic strength, high, rather excessive. Tasted December, 1881.

No. 37—Red Zinfandel; vintage, 1881; sent by Mr. I. DeTurk. Analyzed and tasted February 3, 1882. Color of wine, purplish red, intensity good; flavor, vinous, agreeable; bouquet, clarety, promising; acid, low; astringency, decided; body, good; alcoholic strength, high; dilution (one part of wine to one of water), good. It is remarkably well ripened for its age.

No. 38—Sauvignon Vert wine, sent by Mr. Charles Lefranc, San José, December 26, 1881. Wine of the vintage of 1875. Color, pale topaz white; flavor, good, agreeable; bouquet, light; acid, pleasant; body, light; alcoholic strength, quite high. No change of color was perceptible in the test for tannin. Tasted February, 1882.

No. 39—Riesling wine, sent by Dressel & Co., Sonoma, January 6, 1882. December twenty-first: color, topaz white; condition, clear; bouquet, decided, pleasant; acid, moderate, agreeable; astringency, none; body, light; alcoholic strength, high; flavor, vinous. Tasted December, 1882.

No. 40—Red Zinfandel wine, sent by Prof. G. Husman, Napa, January 8, 1882. The wine has a full, purple color; flavor, high, agreeable; bouquet, undeveloped; acid, medium, pleasant; astringency, good; body, full; alcoholic strength, high; diluted (1–1), gives a good color, pleasant acid, and brings out the astringency not unpleasantly. Vintage, 1881. Nos. 40 to 47, inclusive, were tasted in January, 1882.

No. 41—White Mission, of the vintage of 1881, sent by Professor G. Husman. Color, purplish white, somewhat turbid; flavor not prominent, nutty, agreeable; bouquet, very faint; acid, rather full, pleasant; alcoholic strength, very high.

No. 42—Elvira wine, sent by Mr. H. W. Crabb, Oakville, January 8, 1882. Vintage, 1881. Color of wine, light amber; flavor, high, musky; bouquet, undeveloped; acid, light, agreeable; body, light; alcoholic strength, high; very agreeable wine.

No. 43—Gutedel wine, sent by Dressel & Co., Sonoma, January 6, 1882. Color of wine, white, somewhat turbid; flavor, moderately pronounced; bouquet, undeveloped, will be good; acid, low, almost deficient; body, good; alcoholic strength, high.

No. 44—Lenoir wine, sent by Mr. H. W. Crabb, Oakville, January 6, 1881. Vintage, 1881.

No. 45—White Malvoisie, sent by Prof. G. Husman. Vintage, 1881; color, light amber, nearly clear; flavor, nutty, decided, agreeable; bouquet, undeveloped; acid, decided, pleasant; body, heavy; alcoholic strength, high.

No. 46—Red Malvoisie wine, sent by Prof. G. Husman. Vintage, 1881; color, garnet purple; flavor, agreeable Burgundy; acid, decided, agreeable, less apparent than in the preceding white wine; more

acid than would be expected in a red Malvoisie wine; dilution does not diminish the taste; astringency, decided, agreeable; body, heavy; alcoholic strength, high. The wine diluted (1–1) makes it flat, diluted (1–2) still acid but no astringency or flavor. The wine deposits tartar very rapidly on standing.

No. 47—Rose Chasselas, sent by Prof. G. Husman. Vintage, 1881; color of the wine, light amber; flavor, high, very pleasant; bouquet, undeveloped; acid, weak, almost deficient; body, medium; alcoholic strength, medium. The wine leaves a stalish after-taste.

No. 48—White Mission wine of 1878, sent by Mr. I. DeTurk, Santa Rosa. Color of the wine, topaz white; flavor, faint nutty, vinous, agreeable; bouquet, faint; acid, low; body, light, almost deficient; alcoholic strength, high. Nos. 48 to 52, inclusive, were tasted in February, 1882.

No. 49—Red Zinfandel of 1880, sent by Mr. I. DeTurk. The wine is of a purplish red, light color; very good bouquet; acid, decided, agreeable; astringency, fair; body, fair; alcoholic strength, light; diluted (1–1), gives too light a color; dilutes poorly, maintains acid and astringency but not body.

No. 50—White Mission of 1880, sent by Mr. I. DeTurk. Color of wine, white, faintly reddish; bouquet, none; acid, adequate, agreeable; flavor, faintly nutty; body, light; alcoholic strength, light.

No. 51—White Mission of 1881, sent by Mr. I. DeTurk. Color, reddish white; flavor, nutty, vinous, decided, pleasant; bouquet, questionable; acid, agreeable, adequate; body, fair; alcoholic strength, good.

No. 52—Red Grenache wine of 1876, sent by Mr. Charles Lefranc, San José. Color, purple red, quite decided; condition, bright; bouquet, decided, clarety; acid, decided, agreeable; astringency, decided, adequate; body, medium; alcoholic strength, good.

No. 53—Riesling wine, from B. Dreyfus & Co., through Professor Hilgard.

No. 54—Red Zinfandel wine, from B. Dreyfus & Co. Its color is purplish red, decidedly bright; bouquet, decided, agreeable; acid, pleasant; astringency, decided, agreeable; body, moderately heavy; alcoholic strength, satisfactory. Nos. 54, 55, 56, 57, and 58, tasted in April, 1882.

No. 55—Red Mission of 1881, sent by Mr. Charles Lefranc. Color of wine, purple, fair, moderately clear; flavor, fairly vinous, immature; bouquet, faint, undeveloped; acid, medium; astringency, decided; alcoholic strength, low for Mission. The grapes were very ripe; soil, light gravel; vines, twelve years old.

No. 56—Red Grenache wine, sent by Mr. Charles Lefranc. Color, intense purplish red, clear but not bright; flavor, faintly nutty and faintly vinous; taste is intensely sweet, apparently from added sugar; bouquet, very faint; acid, very weak; astringency, strong. The wine is quite immature; vintage, 1881. The vines were grown on a very gravelly creek bed, and are now ten years old.

No. 57—German Riesling wine, sent in April, 1882, by Kramp & Bro., Diamond Springs, El Dorado County. It has a white color and is turbid; flavor, acetous; taste, decidedly sweet; bouquet, faint, slightly acetous; acid, decided, pungent; light body aside from the sugar present; alcoholic strength, moderate.

No. 58—Elvira wine, from Kramp & Bro. Color of wine, light amber, clear; flavor, vinous; bouquet, decided, agreeable; faintly

musky aroma; acid, moderate, pleasant; no astringency; body, medium; alcoholic strength, rather heavy. The wine appears to be deficient in tannin, leaves a flattish after-taste on the tongue, slightly yeasty; vintage, 1880.

Mr. Kramp gives the following information regarding the two preceding wines: The Elvira wines are grafts on old Mission stocks, and bear about twenty-five pounds per vine. They are pruned about the tenth of April, and receive the required amount of cultivation each way. The grapes were picked about the twentieth of September, when they were just ripe, and fermented at a temperature of seventy to eighty degrees. The wine was drawn off on the sixth of February, and racked on the twentieth of April. The soil of the vineyard is eighteen to twenty-four inches deep, underlaid with a "shelled" granite bed-rock, containing crevices easily penetrated by the grape roots. The must has a fine flavor, without foxiness, and makes a beautiful yellow wine. He further speaks of the grape as one exempt from all attacks of insect pests, not subject to mildew, and thus far has escaped frosts.

The German Riesling has received the same treatment, and was grown on the same soil as the Elvira. The grapes ripen by the end of August, and must be made immediately into wine.

No. 59—California Burgundy, sent by Mr. Charles Lefranc, San José. Color, purple red, quite deep; condition, bright; bouquet, faint, clarety; acid, decided but pleasant; astringency, high; body, heavy; alcoholic strength, low. Tasted in December, 1882.

No. 60—Muscat wine, sent by Mr. I. DeTurk, Santa Rosa. Color of wine, white, becomes brownish red when treated with carbonate of soda, and becomes slightly reddened with salts of iron. The Muscat aroma is very high and very agreeable; acid, decided, pleasant; body, heavy; astringency, decided, surpassingly so for a white wine; alcoholic strength, medium. Nos. 60 to 67, inclusive, tasted in May, 1882.

Nos. 61, 62, 63, 64, 65, 66, 67 are wines sent by Mr. T. F. Eisen, Fresno, April 21, 1882:

No. 61—Zinfandel port wine. Vintage, 1881. Color, purplish garnet; flavor, covered by sweetness; taste, excessively sweet; bouquet, weak, but pleasant; acid, very slight, inadequate; astringency, disagreeable; body, heavy; alcoholic strength, medium. The wine turns black when treated with iron salts and carbonate of soda.

No. 62—Zinfandel port wine of 1878. Color, reddish garnet; taste, excessively sweet; flavor, nutty, agreeable, but largely covered by sweetnesss and astringency; body, heavy; acid, low; alcoholic strength, very high.

No. 63—Muscat wine of 1876. Color, light cherry; flavor, vinous, agreeable; taste, sweet; odor, decidedly alcoholic; bouquet, pleasant, nutty; no Muscat aroma; acid, moderate, pleasant; alcoholic strength, very high; tannin, weak to deficient.

No. 64—Muscat wine of vintage of 1881. It has a very pale cherry color; taste, sweet, decided but pleasant; aroma, decidedly Muscat and "fusel" undeveloped; acid, moderate to deficient; alcoholic strength, high; color, with carbonate of soda and iron salt, very slight.

No. 65—White Malvoisie wine of the vintage of 1878. Color, dark amber, bright; flavor, nutty; taste, moderately sweet; bouquet, light, pleasant; acid, decided, somewhat pungent, unpleasant to faulty;

astringency, covered by acid; body, heavy; alcoholic strength, high. The wine gives very decided color with iron salts and carbonate of soda, and has decided sherry qualities.

No. 66—White Malvoisie of the vintage of 1880. Amber color, somewhat turbid; flavor, nutty; taste, decidedly sweet; bouquet, faint, more developed than in the preceding Malvoisie; acid, moderate, pleasant; astringency, decided; body, heavy; alcoholic strength, very high.

No. 67—Port wine, formed by blending Zinfandel and Teinturier; vintage, 1881. It has a deep garnet color, bright; flavor, indefinite; intensely sweet; bouquet, undeveloped; acid, moderate, pleasant; astringency, excessive; body, very heavy; alcoholic strength, medium.

No. 68—Madeira wine, from B. Dreyfus & Co., through Professor E. W. Hilgard.

No. 69—White Mission of 1873; sent by Mr. J. De Barth Shorb, San Gabriel, June ninth. Color, brownish amber; condition, clear; odor, slightly alcoholic and acetous; bouquet, faint, but pleasant; acid, decided, somewhat acetous; body, light; alcoholic strength, very high. Nos. 69 to 82, inclusive, were tasted in December, 1882.

No. 70—White Mission wine of 1881; sent by Mr. J. De Barth Shorb. Color, light Brazilian topaz; condition, slightly turbid; bouquet, faint; flavor, faintly nutty; acid, low; body, medium; alcoholic strength, high.

No. 71—Blaue Elba wine of 1881; sent by Mr. J. De Barth Shorb. Color, light Brazilian topaz; condition, clear, not bright; flavor, vinous, good; bouquet, undeveloped, promising; acid, moderate, agreeable; astringency, scarcely perceptible; body, good; alcoholic strength, high.

No. 72—Riesling wine of 1880; sent by Mr. J. De Barth Shorb. Color, amber; condition, slightly turbid; bouquet, undeveloped; acid, decided, slightly acetified; body, medium; alcoholic strength, high.

No. 73—Feher Szagos Sherry (sweet) of 1877; sent by Mr. T. F. Eisen. Color, light brown sherry; condition, bright; flavor, faintly nutty; bouquet, malaga rather than sherry; acid, deficient; astringency, quite perceptible; body, heavy; alcoholic strength, high; aroma, pleasant; taste, very sweet.

No. 74—Sweet Malaga wine of 1877; sent by Mr. T. F. Eisen. Color, light brown; condition, bright; flavor, faintly nutty; bouquet, well developed, agreeable; acid, pleasant, adequate; body, medium heavy.

No. 75—Angelica wine of 1875; sent by Mr. J. De Barth Shorb. Color, amber; condition, turbid; taste, very sweet; flavor, nutty; acid, moderate, agreeable; astringency, imperceptible; body, very heavy; alcoholic strength, high.

No. 76—Port wine of 1875; sent by Mr. J. De Barth Shorb. Color, light red; condition, turbid; sweetness, moderate; flavor, nutty, agreeable; bouquet, faint; acid, moderate; astringency, moderate; body, heavy; alcoholic strength, high.

No. 77—Sweet Malaga wine of 1881; sent by Mr. T. F. Eisen. Color, brownish topaz; condition, bright; flavor, faint; sweetness, intense; bouquet of raisins; acid, deficient; body, medium heavy; alcoholic strength, not high.

No. 78—Feher Szagos Sherry (dry); vintage, 1878; sent by Mr. T. F. Eisen. Color, pale sherry; condition, clear; flavor, nutty; sweetness, moderate; bouquet, nutty, good; acid, pleasant, adequate;

astringency, slight; body, medium; alcoholic strength, moderately high.

No. 79—Angelica wine; vintage, 1881; sent by Mr. J. De Barth Shorb. Color, pale topaz; condition, clear; very sweet; flavor, good for its age; astringency, slight; acid, moderate, pleasant; body, heavy; alcoholic strength, high.

No. 80—Port wine; vintage, 1881; sent by Mr. J. De Barth Shorb. Color, red, rather light; condition, slightly turbid; sweetness, somewhat excessive; bouquet, faintly nutty; acid, somewhat low, covered by astringency; astringency, decided, somewhat excessive; body, heavy; alcoholic strength, very high.

No. 81—Charbonneau wine, sent by Mr. J. T. Doyle, of Cupertino; vintage, 1881; soil, gravelly. Color, intense purple red; condition, clear; flavor, vinous, promising; bouquet, undeveloped, claret-like; acid, decided, pleasant; astringency, decided, pleasant; alcoholic strength, low.

No. 82—Red wine, of Vitis Arizonica, sent by Mr. F. Pohndorf from the Viticultural Convention, September 20, 1882. Color, garnet, medium heavy; flavor, vinous, with peculiar "earthiness," strongly pronounced; bouquet, decided, like Bordeaux, with earthy twang; acid, moderate, pleasant; astringency, moderate; body, heavy; alcoholic strength, medium; after-taste, good; the wine resembles the red wine of Pays de Vaud, Switzerland; vintage, 1881.

Nos. 29 and 30—Red wines, sent by Mr. Pellett, St. Helena, January 13, 1881, without statement of origin, except in so far as one of them was suspected of the use of grape sugar in its production. The object of the analyses is a comparison of the two, as they are understood to have been made from the same grape variety.

No. 33—Burger wine, sent by Mr. Robert Hasty, Clayton, February 10, 1881.

No. 34—Red Malvoisie, sent by Mr. R. Hasty. The wine was very turbid, light color, and still fermenting.

No. 31—White wine from Mr. Geo. West, Stockton, February 15, 1881. Straw color; condition, bright; bouquet, faint Sauturne, pleasant; acid, decided, agreeable; astringency, perceptible; body, light; alcoholic strength, medium.

No. 32—Red wine, from Mr. George West.

DISCUSSION OF THE WINES.

For convenience in discussing the different wines, I have grouped together those made from the same variety of grape, and after each group added an analysis of the same variety of wine from that European country in which it seems to flourish the best. Although there have been many partial analyses of foreign wines, there still remains great difficulty in finding those to which we can compare our most common kinds. In the following list the unnumbered analyses were taken from European works on the subject.

Mission Wines.—With this variety we are well supplied, having samples which represent quite all the different districts of the State. As a class they are somewhat deficient in bouquet, with a flavor not prominent; color, medium to light; acid, very agreeable, in some cases full and pleasant; alcoholic strength, high to excessive. The analyses would indicate quite a deficiency in acid; the want of flavor and bouquet, no doubt, gives prominence to the pleasant acid taste

of the wine. The acid of two of these wines is astonishingly large for the variety of grape, noticably that from Mr. Shorb. It at the same time contains an excessively large amount of alcohol, which tends to show some unnatural development of acid. Its supply of true extractives is also large, much larger than would be expected from a wine having so small a per cent of ash.

Nos. 1 to 4, are wines made from the same variety of grape picked at different stages of ripeness; Nos. 1 and 2 were from just ripe grapes. They make a light wine, rather deficient in alcohol—so much so that their keeping qualities must be considerably below that of an ordinary Mission wine. Its body is very light, although the percentage of extractives is nearly equal to that of a standard Mission. The larger amount of acid, no doubt, accounts for the full supply of extractives. The difference in the two kinds of wine is very marked, showing a decided increase, in ripening, in all the constituents excepting acid—this decreased to a remarkable extent, amounting to thirty-five or forty per cent of the first test. The amount in the unripe grapes is just sufficient for a moderately acid wine, while in the last two the acid is quite deficient, especially in the red wine. The increase in alcohol is sufficient to change the light wine of the former to a strong, spirituous wine of the latter, the difference in the red wines being much greater than that in the white.

The per cent of ash was increased only slightly in the case of the white and considerably with the red wines. With regard to organic matter, the change was appreciable, but not very marked—noticeable from the fact that the white increased more than the red. In comparing the red and white wines, the former is much more spiritous, heavier body, and shows a more marked difference in the kind of wine made from the grapes of different stages of ripeness.

Black Prince.—This variety of grape, coming originally from France, has few or no qualities which would recommend it for a good wine grape. It is poor in color; wanting in bouquet and astringency; body rather light, and alcoholic strength too high.

Scarcely any difference can be noticed between the analyses of the white and red wine; that in the per cent of ash being most noticeable, and even this is not marked. The specific gravity of both wines is low, and the residue by the spindle is high, somewhat excessive. The difference between the residues by spindle and evaporation is large and can be accounted for only by the theory that a large amount of glycerine, which is driven off by evaporation and drying of the residues, is produced during a vigorous fermentation. In this variety the per cent of alcohol is high to excessive, sufficient to have produced, during the fermentation, nearly one per cent of glycerine. The per cent of organic matter is medium to light. The quantity of acid is surpassingly large; we would expect a deficiency in a wine carrying such an excessive amount of alcohol.

Malvoisie.—This variety is grown in the southern and western part of France, where it produces a wine of much color, strength, and alcohol, and of little bouquet. As grown in this State it produces a wine of very good color; a nutty agreeable flavor; somewhat wanting in bouquet; fair amount of acid; decided astringency; heavy body, and high alcoholic strength. It usually has a sweetish taste, and the samples analyzed have more or less sugar, indicating a possible difficulty in complete fermentation. As an unblended wine, it meets with but little favor, being much too "heady" and possessing

few of the qualities of a delicate wine. It is said to be hard to keep, but blends well with wines deficient in body and alcohol, and imparts good color to inferior colored wines.

The analyses show a moderate amount of acid in all cases excepting No. 8, where it is decidedly deficient, being considerably less than that of the original must. The per cent of alcohol is high, Nos. 7 and 66 carrying two to three per cent more than any of the other natural wines. The regularity of the per cent of ash is quite noticeable, considering the varied results obtained for the other constituents; in only one case, that of No. 45, does it fall far below the average high per cent. It is remarkable that No. 7 fermented so completely, for it certainly shows a high per cent of fermentable substances.

Zinfandel.—These wines possess a full, clear color; flavor generally high and agreeable; odor, quite characteristic, although not prominent; bouquet, good; acid, moderate and pleasant; fair amount of astringency; body, full, and alcoholic strength high to excessive.

Of the chemical analyses there is but little to be said. They show an abundant supply of extractives, and give uniform but full results for the organic matter determination. Of ash there is a fair but not excessive amount.

Charbonneau.—Of this variety we have scarcely enough samples to make any comparison. The two samples, 9 and 10, are light, poor wines, with high specific gravity; a decided deficiency in alcohol, and high acid; bouquet and astringency decided.

No. 81 makes a better showing than the two preceding wines; with sufficient amount of alcohol, moderate supply of acid, and residue enough to give it the proper body, it will, no doubt, develop into a good wine. It is continually depositing tartar to excess, as do all the wines of this variety. The high ash of the residue shows a proper combination of acid and ash, leaving no free acid. As a wine grape it can only serve in combination with others, while its special excellence as a brandy grape of high quality has been demonstrated by General Naglee.

This variety of wine matures slowly during the first stages, but we have reason to believe that during its later stages it will develop more rapidly.

Grenache.—No. 52 promises to be a light, acid wine. It has been kept for several years, and this, no doubt, may account for its having a much larger amount of acid than the wine of 1881. The medium per cent of extractives makes it full-bodied, and leaves a heavy ash. No. 56, of the same variety, is already a stronger wine than the preceding, and still contains sugar enough to bring it up to a very spiritous wine, if fully fermented. Its acid is deficient.

California Burgundy.—Of this variety there is but one sample. What variety of grape it was made from is doubtful, but from the close correspondence in the analysis of this wine and the Grenache, we may consider them as chiefly of the same variety.

Lenoir.—Possesses a remarkable body and color, high acid, and moderate amount of alcohol. It is not a palatable wine by itself, but for blending purposes is desirable for the body, color, and acid which it imparts to the blend.

Chasselas.—These wines are generally high-flavored, with rather small amount of acid, somewhat lacking in body; full alcoholic strength. The first noticeable feature of the Chasselas wines is their

low specific gravity. Very little variation can be traced between them, but when we compare the specific gravity of the dealcoholized wines, a wider range of differences is seen. This should not follow, as the chief element in changing the specific gravity is the alcohol, which in this case is almost constant. Organic matter and ash fall below the usual average of wines. The alcohol per cent is high. The acid in two cases is deficient, while the remaining three are full.

Riesling.—Of the white wine grapes of this State, the Riesling seems to be the most prominent as a wine producer. The wines are generally well supplied with alcohol, medium acid, light body, and pleasant bouquet.

The analyses show it to be a wine of low specific gravity; its residue by specific gravity is large, and shows a superabundant quantity of volatile ingredients; its organic matter is full, and gives a medium body to the wine. The percentage of ash is low for California wines, with exception of No. 12, which is excessive. Acid and alcohol are combined in proportion to make a very strong aromatic wine. The acid is full to excessive.

The wines analyzed compare favorably with those of European growth. They are more acid, and have a slightly higher alcoholic strength—otherwise scarcely any difference can be noticed between them.

Blaue Elba, a grape which makes a wine very similar to the Riesling, should be discussed and compared with it. The correspondence in the analyses of the two varieties shows them to be nearly related in their qualities.

Burger.—This variety has not, as yet, been classified, but without doubt, belongs to the Rhenish group of wines. The grape is very acid, and contains only a small amount of sugar. It makes a very light wine, deficient in alcohol and body, and contains too much acid; bouquet, faint. Alone, it has no basis upon which to build a wine of any character whatever. In the analyses, the amount of organic matter by evaporation is too large, the residue by dealcoholized method being nearer the proper amount. The ash is low, but sufficiently high for a wine of so little body.

Feher Szagos.—This wine resembles quite closely the Burger; it has a sufficient amount of acid, but is wanting in alcohol and body. Its ash per cent is excessively large, as is the case with nearly all the wines of the district from which this was obtained. It is very liable to acetification.

Prolific or Sauvignon and Sauvignon Vert.—The Prolific has not until recently been classified. Its close resemblance to the Sauvignon places it unmistakably in that group of varieties. I will, therefore, treat the Sauvignon Vert and Prolific together. The analyses show them to be wines of full body, well supplied with volatile constituents to give them a sufficient amount of aroma, bouquet, and flavor. The ash is medium. The alcoholic strengths are high to excessive, and, taken with the larger amount of acid, will in time produce a wine of decided character. For comparison I have taken a Sauterne from the white-wine district of France. Our analyses compares favorably with the one selected from the foreign analyses. They contain more alcohol, less ash, and about the same per cent of acid.

The *Elvira* possesses many qualities that will recommend it to those who like a musky wine. It usually gives a slightly musky

aroma and flavor; a pleasing bouquet; a medium acid and body, and somewhat too heavy alcoholic strength. The analyses show the mountain sample, from Diamond Springs, to be much richer in ash than the valley sample, and at the same its percentage of organic matter is less. Its alcoholic strength is excessive, while that from Oakville is in about the proper proportion for the medium acid present.

Very little can be said of the chemical analyses of the sweet wines which form the remainder of our list. There is such a wide range in the respective amounts of sugar, alcohol, and other constituents composing the different Ports, Sherries, etc., that an analysis will not form a true basis upon which to value the wine; furthermore, they are usually the result of various "mixtures" fortified by foreign spirits, so that no two consecutive vintages will be the same.

Of the *Sweet Malagas* we have two samples, each possessing a faintly musty flavor, good bouquet, medium body, and insufficient amount of natural acid. The ash is excessively high. In the analysis the wine compares favorably with that of the Malaga from Spain.

Madeira.—Comparing the partial analysis of California Madeira with that of the Atlantic Islands, little or no difference is observable. The California sample possesses a higher specific gravity and a corresponding higher residue, which is largely sugar. The alcohol per cent is about the same in each.

The *Muscat* wines which we have received have had a high alcoholic strength, accompanied by a full amount of acid; the muscat flavor was entirely lacking in the older one, and very strong in the others.

The dry Muscat from Santa Rosa is remarkable for its complete fermentation, its low per cent of organic matter, and medium ash. Its alcohol is low, surprisingly so for this variety. The other samples sustain the reputations of their district in producing a high ash, excessive alcohol, and still have sugar enough remaining to make the wines very sweet. The must from which these wines were made carried at least forty per cent of sugar. The grapes were probably well dried before they were picked.

The acid in the Muscat and Malaga of 1881 is notably low.

Ports.—Those examined of this class of wines are mostly deficient in bouquet, have a heavy body and alcoholic strength, a rather unpleasant astringency, and low acid. The analysis shows a very varying amount of each of the constituents, except alcohol; this for our Ports seems to be quite constant. They contain the maximum amount to be expected for unfortified wines. The large per cent of sugar in two of them indicates that evaporated grape juice was used in their production. The ash of the Fresno Ports is very high; that of the San Gabriel district low to high, ranging from two to four-tenths per cent. The acid of the latter district follows almost exactly the per cent of its corresponding ash.

The analyses of the Spanish and Portuguese wines vary but little from those of our own wines. In alcoholic strength they are slightly lower, in acid slightly higher, and in ash falling somewhat below the average California Port. In residue and sugar little difference is noticeable, when we consider the wide range this constituent has in Ports. Only two of ours notably exceed the foreign wines in sugar.

Among the wines from San Gabriel are two *Angelicas*, possessing a good flavor, moderate acid, slight astringency, high body, and alco-

holic strength. The condition of the older wine seems to be less promising than that of the younger. The sugar remaining makes each wine exceedingly sweet; the determination in No. 79 is probably too high. The acid and ash are both very low, notably the acid. There seems to be sufficient acid to produce a pleasant taste, yet the analysis reveals a very decided deficiency in this ingredient, and it could be scarcely tasted unless some other element of the wine brought it out and made it more prominent. The Angelica of 1881 contains less acid than any wine thus far analyzed.

We have, also, two Feher Szagos *Sherries* from Fresno, one sweet, the other dry. Of the two, the dry seems most promising, having all its properties equally developed, and none to excess. For a dry Sherry its alcoholic strength is well balanced by a medium body and acid; sufficient sugar was left to give it a sweet taste. The excessive sweetness of the sweet wine overpowers the more delicate properties that are brought out more prominently in the dry. The nutty flavor of the former becomes fainter in the latter, and the bouquet changes to that of a Malaga wine. The sugar determination is probably too high, yet it cannot fall below eighteen per cent, an amount about equal to the natural sugar of the grape, as shown by our analysis. The percentage of alcohol in the wine calls for nearly thirty per cent of sugar, showing that the grapes have been dried to, at least, one half of their bulk before making into wine. The acid, on the contrary, has very considerably decreased. The ash remains about the same.

Comparing a Spanish Sherry of 1865 with the California Sherries, a striking similarity to our dry Sherry is noticeable. It contains but a half per cent more of sugar, and about the same excess of residue. In ash, it is higher than either Sherry; in acid, it falls just between the sweet and the dry.

The grape varieties from which the remaining wines were made are unknown. The first two will be discussed by themselves.

Nos. 29, 30—*Wines sent by Mr. F. A. Pellet*, of St. Helena, for examination as to the use of grape sugar in the same. A comparison of these wines in the table show the following points of difference: No. 2, the specific gravity is greater by .010—a corresponding difference appearing in the dealcoholized wine. The amount of residues, whether determined by spindle or evaporation, is greater in the ratio of two to more than three. In the ash percentage, this difference closely approaches to an excess of fifty per cent. In the acid and alcohol percentage, also, No. 2 materially exceeds No. 1; while, on the other hand, the amount of bitartrate in No. 2 is to that of No. 1 as three to four—the acid per cent in both is very small. While the polariscope gave no definite indication, the copper test for sugar showed by its unusual character (the production of yellow instead of red precipitate) the presence of a substance foreign to a natural wine.

INFLUENCE OF LOCATION ON THE CHARACTER OF WINES.

In treating of this part of the subject, we cannot as yet divide the whole State into districts. The general characteristics of the larger districts are popularly known. I will therefore treat of the *localities* from which we have received wines. Some of these include quite a large district, which might properly have been subdivided. The St. Helena District includes a region extending from Oakville to three miles above the Town of St. Helena; the San José District, all the

country south of, and adjoining the San Francisco Bay. The Martinez District includes, also, a spot near Clayton. The Los Angeles should properly be called San Gabriel District. Napa is represented by a single vineyard midway between Sonoma and Napa. The remaining localities are supposed to be the centers of the districts which they represent.

It should be remembered that, in order to compare the relative effect of any district upon a grape variety, we should have numerous analyses of the wines of the same vintage. Our analyses are too meager to make a complete and definite comparison, but will serve as an indication of what should be taken up in the future.

First, we will make a general comparison of the districts. If the analyses of the wines of each district be so grouped that the like components shall be together, we can then take the average of each for its district, and show about the following general characteristics: The Sonoma District will show a medium to low amount of ash, carrying less than any of the other districts; its alcohol per cent is medium to high, and, no doubt, combines remarkably with its reasonable amount of acid; its extract is decidedly low. Its neighbor, the Santa Rosa District, shows a higher ash, a slight decrease in alcohol, and a corresponding slight increase in acid, placing it considerably above the medium in acidity. Its extractives cannot be compared with Sonoma District as we have an entirely different kind of grape for the comparison.

The St. Helena District gives us a wine very high in ash, and quite low in alcohol, at least below a medium; its acid is moderate, just sufficient for its alcoholicity; extractives, high. Napa District is represented by a single vineyard at some distance from the city. Of the five wines that were contributed only one was completely fermented. The ash per cent falls somewhat below that of Santa Rosa and St. Helena, but may still be classed as high; its alcohol is higher than that of six of the other districts, still not excessive; its acid is below the medium and scarcely sufficient for such strong wines. The extractives of the only wine free from sugar fell slightly below the medium.

We have eight wines from the Stockton District, representing the chief varieties of that locality. Compared with the other districts it may be said to be rich in all its constituents. The ash is high; alcohol is high to very high; its acid is full to high, and the residue is about medium.

The chief and notable feature of the Fresno District, is the excessive ash, averaging nearly four tenths per cent; alcohol, acid, and extractives are about medium.

The Martinez District is represented almost entirely by Mission wines, which show, as is usually the case with this variety, a high ash. Both alcohol and acid fall considerably below the medium; its extractives are full too high, larger than in any other district.

San José District presents another case of very high ash, and a correspondingly small amount of alcohol; its average in alcohol being less than that of any other district. Its extractives are full, and acid medium.

Los Angeles District—Medium ash, alcohol high, exceeded only by the amount in Stockton District. Its acid is very high, larger than that of any other district. Extract, full.

The remaining district, Diamond Springs, has not sent enough specimens to form any opinion of the district.

If we discuss in detail each district, we will find that the variety of vine may account for some of the apparent discrepancies. Coming again to the Sonoma District, it will be seen that the two varieties, Chasselas and Riesling, are wines that should give only a small ash, even smaller than the amount we have obtained as compared with European wines.

If we take a single wine, grown in several districts, we may show the effect of surroundings on the varieties. We have *Mission* wines from Santa Rosa, Stockton, San José, Los Angeles, Napa, and Martinez. They show a wide range in ash, varying from low to exceedingly high; Stockton and Martinez carrying the highest per cent, Santa Rosa and Napa the lowest; the last two were white wines and ought to have given a lower per cent. In alcohol, the Los Angeles District takes the lead with a very high per cent in one wine, Napa and Martinez also give a high per cent, while the other districts are below the medium amount. A marked difference is noticeable in the acid per cent, which I think is largely due to fermentation and keeping. One of the wines from Los Angeles carries seven tenths per cent, an amount sufficient for the most acid variety of wines, while the other Mission, coming from the same place, bears less than five tenths per cent, and is still too high, as are also those made from Stockton grapes. The best Mission from Martinez shows the lowest per cent, exceeded only slightly by those from Santa Rosa. San José and Napa presents about a normal amount for this variety of wine. With regard to residue they may all be classed as very low, with the exception of Martinez District, and one wine from Los Angeles. A large number of them have been imperfectly fermented, and still contain sugar.

We have the *Malvoisie* wines from four districts. In amount of ash they exceed those of any varieties we have yet analyzed, being excessive in nearly every case. The average amount is over three tenths per cent, and in several cases almost four tenths. Fresno carries the largest amount, and St. Helena, with a small decrease, stands next. Napa presents a peculiarity in having, at the same time and vintage, a Malvoisie carrying the lowest, and, with one exception, the highest ash of any of the districts. It shows plainly the difference between red and white wines produced from the same grape. Two of the wines contain an excessive amount of alcohol, and in all of them it is high. One from Fresno shows 17 vol. per cent, and enough unfermented sugar in the residue to increase it to nineteen or twenty per cent. It was an excessively sweet must that could have produced such a wine—doubtless produced by excessive ripeness or drying of the grapes. The amount of acid is very variable. In Fresno samples, where a small amount would be looked for, we find it above the medium; in Napa, full; in St. Helena, low to deficient. Little or no conclusions can be drawn from the residues. Out of seven, five contained sugar. This shows great difficulty in fermentation. Of the two that were completely fermented—one white, the other red—the former was above a medium in residue; the latter, high.

The *Zinfandel* comes to us from Santa Rosa, St. Helena, Stockton, and Napa. The three red wines from Santa Rosa are high in ash, one containing an excessive amount, exceeding all the others. If the red wines above are compared, very little difference in ash can

be noticed in the different districts. Stockton District seems to produce Zinfandel lower in ash than the other districts. Her white Zinfandel is somewhat less in ash than the corresponding one from St. Helena. While Stockton District carries the least ash in this variety, she at the same time has the highest per cent of alcohol. Each district is just above the medium in this constituent. Of the eight Zinfandels, four are below the medium in acid; the remaining number are high; Santa Rosa is best supplied. The red wine from St. Helena contains a high per cent of residue; all the others contain about an average amount.

If we take any two districts that have sent two or more samples of the same kinds of wine, we may be able to show that the effect produced on any one variety of a district will not be a guide as to the effects that may be produced on any other variety. If one variety of wine of a certain district is low in ash, and the vine be removed to another district notable for its ash producing properties on vines already established, it does not follow with certainty that this transported variety will also increase in ash in the same proportion as did the other varieties; neither is it sure to increase in other constituents. For instance: Santa Rosa, Stockton, and Napa have sent us Mission and Zinfandel wines. Comparing them, it is seen that Stockton has the highest average ash in the Mission variety; Santa Rosa next, and Napa least. In the Zinfandel the order is nearly reversed; Santa Rosa producing the highest amount, Napa next, and Stockton least. The per cent of alcohol is inversely proportioned to the ash, while the acid varies directly; or, in other words, these two varieties are oppositely affected by these districts.

We also have Malvoisie and Zinfandel from St. Helena and Napa. The variation in these wines is much less than in the preceding; still it is noticeable. The St. Helena varieties are grown on low valley gravel land, while that of Napa is higher and stronger. St. Helena produces a higher Zinfandel ash than Napa, while the Malvoisie ash in Napa exceeds that of St. Helena. The proportion of alcohol and acid in these two wines follow the rule as given in the preceding case, and the effects produced are opposite. Santa Rosa is specially productive of Zinfandel ash, but acts oppositely with the Mission; Stockton produces a high Mission ash, but low Zinfandel.

EXAMINATION OF LEES.

The first residues which settle from the wines during fermentation (lees), were collected, dried, and partially analyzed. It is a matter of considerable importance in the first stages of wine-making to know the nature of this material settling to the bottom of the fermenting vessels. If it be of a very yeasty nature and prolongs the fermentation, or produces mucous changes, or, if it be largely tartrates which may be decomposed and produce "turning of the wine," we should know it, so that the evil may be prevented by an earlier racking, or by such other means as will free the wine from the injurious sediment. The possible beneficial influence of the lees upon the body of the wines should not, in the meantime, be overlooked in considering the length of time the lees should remain before disease may be produced. Wine and lees should never remain together until changes injurious to the wine are threatened; and the effect of the lees upon the nature of the wine has not received the attention that its

importance demands. If it be the case that a heavy ash, for instance, is detrimental or beneficial, then it becomes to the interest of all wine-makers to study some means of increasing or diminishing it as the circumstances may require. A certain blending of the must may produce the desired effect, but this cannot always be resorted to, as the vineyard that will produce an ashy wine of one variety will probably give a like increase to the other varieties. The other possible remedy, then, is to study the fermentation, and either prevent or increase the precipitation of ash-substances in the lees, which would eventually form the ash of the wine. Very little is known regarding this change more than that an increase in alcohol decreases the solvent powers of the fermenting mass and increases the precipitation. A regulation of the rapidity of this change may be of benefit to the wine maker, and it may be within his power to precipitate the organic matter completely at first and follow it with a precipitation of mineral matter at whatever stage he wishes. Other points of importance naturally arise which can be understood only by a careful study of the lees themselves.

DESCRIPTION OF THE LEES.

The lees that were dried may shortly be described as follows:

White Mission (early).—Very soft; is easily reduced to a light chocolate powder; color is dark gray.

Red Mission (early).—Very hard black mass, and produces a dark yellow powder.

White Mission (late).—Chocolate color; becomes slightly lighter when powdered; is hard, but powders without difficulty.

Red Mission (late).—Extremely hard, can scarcely be cut with a knife; color, chocolate to black, and also has a purple tint; is quite homogeneous.

White Zinfandel.—Soft, cuts like talc; is of a light yellow color; reduces quite easily to a soft impalpable powder.

Red Zinfandel.—Dark, slightly purple color; produces a distinctly purple color when powdered; very hard.

White Malvoisie.—Soft, powders easily to fine dust; light chocolate color; becomes very little lighter in color when powdered.

Red Malvoisie.—Quite hard; dark color, with purple tints; forms a light purple powder. The upper part is covered with a very hard black layer, which is powdered with difficulty.

White Charbonneau.—Chocolate color; quite hard; talcy in appearance when cut; powder slightly lighter color.

Red Charbonneau.—Color black, with a purple tint on the inside; powder is a light purple color; hard, only part of it is compact.

White Burger.—Quite hard; dark, almost black, color; spotted all through with white spots.

"*Red*" *Burger.*—Very dark brown to black; hard; cuts smoothly with a knife; powders with difficulty, changing to a dark chocolate color.

White Chasselas.—Very soft; easily pulverized between the fingers to a soft impalpable dust; dark straw color; quite homogeneous.

"*Red*" *Chasselas.*—Extremely hard and brittle; reduced with great difficulty from a dark yellow to brown powder; color, dark brown to black.

Golden Chasselas.—Very hard, brittle; dark brown color; powder

Name.
Mission, just ripe
Mission, just ripe
Mission, fully ripe
Mission, fully ripe
Zinfandel
Zinfandel
Malvoisie
Malvoisie
Charbonneau
Charbonneau
Burger
Burger
Chasselas
Chasselas
Golden Chasselas
Prolific
Prolific
Zinfandel
Zinfandel
Mission
Mission
Black Prince
Black Prince
Feher Szagos
Feher Szagos
Mataro
Mataro
Lenoir

is of a dark yellow color. The whole is stratified with extremely hard black layers.

White Prolific.—Soft, very porous; easily pulverized to a fine impalpable dust; color, very light chocolate, becomes much lighter when powdered.

"*Red*" *Prolific.*—Soft, quite porous; color, light chocolate, becomes lighter when powdered. It is harder and has a darker color than the White Prolific lees.

White Zinfandel.—Quite soft, easily cut. It has a chocolate color, with a slight pinkish shade; easily pulverized, and changes color slightly.

Red Zinfandel.—Extremely hard; the powder is harsh and rough; dark purple color, becomes somewhat lighter when powdered.

White Mission.—Soft, very porous; can be crushed between the fingers, but with difficulty; dirty pinkish gray color, scarcely changes when powdered.

Red Mission.—Soft and porous, harder than the White Mission lees. Purplish brown color, when powdered becomes browner. Has the appearance of tufa.

White Black Prince.—Hard, quite easily cut; yellowish brown, becomes lighter when powdered.

Red Black Prince.—Very hard, brittle; brown to dark chocolate color.

White Feher Szagos.—Hard, brittle, porous, cuts easily; color, dark brown; powder is light chocolate color.

"*Red*" *Feher Szagos.*—Hard, tenacious to brittle; dark brown color; powders with difficulty.

White Mataro.—Quite hard, easily pulverized to fine impalpable powder, which looks like dried "slickens"; color, gray.

Red Mataro—Very hard and brittle; difficult to powder, is gritty, and has a purple color; color, dark with purple colored strata through the inner portions.

Lenoir.—Very hard and brittle; color, black with a purple tint; powder, dark purple.

The tables show the extent to which the analyses have been carried. The *total* weight of lees includes moisture that was not driven off at a temperature of about 45° (C.), the temperature at which they were first dried. Following the determination of quantity, is a determination of moisture at 100° (C.), ash by ignition and organic matter by loss.

The percentage of ash indicates the relative amount of tartar present. This, of course, may be composed of several different salts, but for comparison may be considered as tartrates of lime and potash. To determine approximately the relative amount of these salts, the total ash produced by the ignition of the lees was separated into soluble and insoluble parts, the soluble representing the carbonate of potash, the insoluble, the carbonate of lime produced from the corresponding tartrates. The corresponding percentage is given in the table.

To determine the alkalinity of the soluble part of the ash, it is titrated with a standard solution of sulphuric acid (.049 grms. per cubic centimetre). In the last column but one is given the total amount of potassium in the soluble part, from which the amount of crude tartar originally in the lees may be determined; the last column represents the per cent.

The white wines produce heavier deposit of lees, with larger percentage of ash, and a corresponding smaller quantity of ash in the wine. Their fermentation, as a rule, has been more rapid and violent; the ferment cells having a greater chance to act upon the sugar before settling to the bottom of the vessel.

The production of alcohol is quicker in white wine, and consequently precipitation should follow sooner, but the greater freedom of motion may keep the lighter organic substances from settling, while the inorganic settle more rapidly by the increase of alcohol. The higher temperature may also exert some effect.

The Feher Szagos and Chasselas are the only wines in which the lees of the "red" wines are larger than from the white. Both are low in potash salts, and correspondingly high in lime salts.

The percentage of alcohol does not produce a noticeable effect upon the precipitation; the latter is governed more by the amount and nature of the ash in the must. Those lees which produce limy ashes do not precipitate so soon as lees rich in potassium, and the difference between the white and red wine deposit is much lessened. In case of the Feher Szagos, the two are about the same. The "red" and white Chasselas contain a large amount of lime, and their deposit of lees is nearly the same, the "red," contrary to the general rule, being more than the white. The red wine lees generally contain more lime than the corresponding white ones.

It is to be regretted that we have not more wines of the same variety grown in different years, so that the deposit of the two years might be compared. However, we have two varieties grown in 1880 and 1881, which will show somewhat the effect of different years. It will be remembered that 1880 was a year in which grapes did not ripen until late, and the production of sugar was very small and acid correspondingly large. In the first year the Mission (fully ripe) and the Zinfandel produced a heavier deposit of lees than in the following year, when the development of fruit was much more perfect. The lees, on the contrary, were much more ashy in 1881. The Zinfandel contained more lime and less potash, while the Mission produced the opposite result. The development of alcohol in 1880 Zinfandel was less than in 1881, while the alcohol of 1880 Mission was larger than in 1881. The earlier Mission, of the year 1880, shows a surprising amount of lime, and still retains in the soluble part a good supply of potash. The vintage of 1880 shows a higher per cent of organic matter in the lees.

It would be interesting to know how much of the organic matter of the lees consists of yeasty substances not used up during fermentation, and still capable of producing an after-fermentation. This can only be approximately determined by deducting from the total amount of organic matter the amount of tartaric acid required to combine with the ash to form tartrate salts, since much of this organic substance consists of matters incapable of effecting fermentation. The results show, roughly, as in the case of the total organic matter, a larger amount for the red wine, and also a far greater difference between the amount in the two kinds of wine, amounting in some cases, notably Chasselas, to fifty per cent, while in the opposite extreme, the Malvoisie, it is scarcely five per cent, and in Mission only three. Prominent among the very yeasty lees, is the Lenoir, Chasselas, Burger, Red Charbonneau, and Red Zinfandel. Each of

these wines passed through a notably low fermentation with very little increase in temperature.

The effect of a deficiency of albuminous matter is shown in the Prolific wines. The fermenting temperature was favorable; there was a large amount of sugar; in fact, all other conditions were favorable for a high and excellent fermentation. But the fermentation began failing at the end of the third day, leaving some of the sugar unfermented. The red wine was also interrupted before all the sugar was fermented out.

It would have been desirable to have determined accurately the amount of albuminous matter, but lack of time has prevented such a determination.

By comparing the lees deposit at different times the order of precipitation can readily be seen. In the red wines tartar begins to deposit before the pomace is separated, then follows a stage in which the deposit is largely organic matter, accompanied by tartrates of potash and lime, the latter predominating. The nature of the deposit on the pomace is not known, but without doubt is largely potash salt. The white wine produces lees rich in the same salts, leaving the lime to form the chief part of the ash of the wine. The nature of the deposit at this stage naturally determines the kind of ash that will remain in the wines. As we have a lime ash in the red lees we may expect to find an ash rich in potash in the corresponding wine; and such is the case. It is known that red wines are usually richer in potash salts, while white wines contain lime salts in largest proportion.

It will be seen from the table that the red wine lees are much more productive of lime salts than the corresponding white wines. We must remember that the lime per cent includes all the salts that are insoluble, which, no doubt, appreciably increases the per cent.

The year of vintage seems to have a decided effect on the kind of salts produced. The table representing the lees of 1881, shows a very decided increase of lime in both kinds of wine, but much more increase in the white. The amounts in the two kinds are nearly equal, and in some cases the white exceeds the red, while in 1880, nearly twice as much lime appears in red, and at the same time in the soluble part much less alkali is present.

The Mission wines of 1880, give for the earlier grape an immense proportion of lime; the grape picked later has still a high per cent, yet it shows a decided decrease. This difference may be caused by some influence the alcohol has upon the precipitation of lees.

The percentage of *moisture* varies considerably and has apparently nothing to do with the real composition of the lees. Its quantity follows closely that of the organic matter, and shows plainly, by their easier drying qualities, the crystalline structure of those lees rich in ash and a corresponding amorphous structure of those which dry with difficulty.

Comparison of ash and acid, before, during, and after fermentation.— In order to show the relation, if there is any, existing between the ash and the acid in the must, or during any stage of the fermentation, or after the fermentation is complete, I have collected from the preceding analyses such determinations as bear upon this point.

Table No. VI.

Showing relations between Ashes of Lees, Must, and Wine, and Acid of Must, resp. Murk, and Wine.

Name.	Color of Wine	Ash, per cent.				Acid, per cent.		
		Must	Lees, air-dried	Lees referred to 100 c. c. m. Wine	Wine	Must	Murk	Wine
Mission, just ripe	White	.281	24.33	.1062	.230			.537
Mission, just ripe	Red		18.62	.0617	.318	.414	.281	.540
Mission, fully ripe	White	.400	19.75	.1195	.244			.349
Mission, fully ripe	Red		11.66	.0620	.396	.458	.360	.330
Zinfandel	White		19.36	.1507	.186			.600
Zinfandel	Red		8.17	.0417	.291	.405	.394	.390
Malvoisie	White	.454	19.85	.1465	.316			.427
Malvoisie	Red		10.56	.0651	.337	.338	.295	.246
Charbonneau	White	.358	17.75	.1143	.204			.475
Charbonneau	Red		9.18	.0330	.318	.657	.563	.442
Burger	White	.234	11.61	.0962	.162			.562
Burger	Red		7.01	.0300	.230	.677	.750	.525
Chasselas	White	.390	25.92	.1181	.191			.633
Chasselas	"Red"		7.91	.0440	.245	.243	.337	.649
Golden Chasselas	"Red"	.315	11.08	.0400	.293	.270	.337	.592
Prolific	White	.473	26.86	.1605	.187			.675
Prolific	"Red"		23.23	.1285	.236	.697	.615	.534
Zinfandel	White	.397	22.40	.1482	.156			.420
Zinfandel	Red		12.15	.0625	.266	.540	.439	.437
Mission	White	.395	21.51	.1102	.252			.669
Mission	Red		20.70	.0784	.332	.285	.397	.559
Black Prince	White	.622	22.91	.1751	.298			.702
Black Prince	Red		16.27	.0907	.365	.260	.345	.645
Feher Szagos	White	.542	17.07	.0919	.391			.562
Feher Szagos	"Red"		12.99	.0878	.441	.315	.410	.525
Mataro	White	.405	19.69	.1652	.254			.424
Mataro	Red		12.24	.0922	.387	.225	.247	.525
Lenoir	Red	.776	10.02	.1832	.571	.600	.581	.807

The first division of the table gives the percentage of ash in the must, in the deposited lees dried at 100° (C.), and percentage of ash thus deposited from the wine; and also per cent of ash of the wine.

In the second division are placed the acid determinations of must, of the wine just as it is pressed from the pomace before fermentation is complete, and lastly, the acid of the finished wine.

The table shows a decrease in acid during fermentation for those musts rich in acid, and an increase in acid for must low in acid and at the same time bearing a large amount of ash. The cause of the latter change is found in acetification, as was shown in our discussion on residues.

The first change is no doubt due to the deposition of tartar which carries with it a certain amount of unsaturated salts in the form of bitartrates. This change is very regular, and is a result which we might naturally expect. It will also be seen that the white musts do not decrease in acid as much as the red, and when an increase occurs it is usually greater in the former. A decrease in acid occurs only in musts rich in acid, and those which bear a heavy ash suffer less change. This follows only in wines which decrease

in acid, and tends to show that acetification and like changes come more frequently to low-ash musts with high acid. This might have been expected, for the heavier ash accompanies a full-bodied, strong wine; one that is not easily affected by external changes, and is less subject to disease. The high acid produces the vigorous prompt fermentation, leaving little chance for any but favorable condition for the maturing of the wine. It is also seen that a high ash does not secure proper fermentation if the acid is lacking. A deficiency or excess of either ash or acid determines the kind and amount of acid in the mature wine.

The white wine usually suffers a greater change during an increase of acid than the corresponding red wine, and, also, loses less when a decrease occurs. If this acid change were produced by acetification, we would expect just the opposite effect. The red wines are more exposed to the air during the first stages of their fermentation, and hence should acetify more rapidly. The white wines have but a small surface in which acetous action can take place. The temperature, also, is more favorable for the change in the white wines.

If we compare the difference in acid between the must and murk with the ash of the must, it follows more directly that the rule previously applied to the change in acid in the wines, will be true.

To show the possible effect of fermentation upon the changes, take two anomalous cases of increase and decrease in the same wine, that of the Mission, just ripe, and the Burger. In the first case we have a must very low in ash, quite high in acid, and a murk exceedingly low in acid; followed by a wine correspondingly too high in acid, which has been formed during fermentation. According to the rule established above, we would expect a very decided decrease in acid; this we find fully carried out in the first stages of fermentation; but when the wine is analyzed, we find, on the contrary, an *in*crease in acid. Referring now to the table of fermenting temperatures, we see that the Red Mission passed through a very favorable fermentation during the first few days; the temperature being higher than that of its corresponding white wine. It was pressed October twenty-third at the end of this prosperous fermentation, and showed the expected decrease in acid. A day or two previous to pressing, the fermentation was impeded by a fall in the room temperature, before all the sugar had fermented out. With the return of proper room temperature fermentation again increased, but not so violently as before. At this stage the acetous fermentation may have taken place, and caused the final increase.

The Burger is a case of the opposite change produced by fermentation. This variety is notable for its extremely low ash in the must and corresponding high acid; it should suffer a very large decrease during fermentation; on the contrary it has decreased only a small amount in the mature wine, and has increased during the violent fermentation. Referring again to our temperature table, we find that the "Red" Burger, instead of rising in temperature during the first few days, really decreased and fermented slowly. At the end of two days it began subsiding. The pomace was pressed November thirteenth, after the wine temperature had fallen below that of the room. The possible acetous fermentation took place just before pressing, as there were three days of very little action, and at the same time great exposure of the murk to the air, conditions favorable to acetous change. The final decrease in the

acid of the wine over that of the must may be accounted for by the very heavy deposit of tartar in the pomace, which, in the red wine, nearly equaled that of the white. If the excess of acid of the murk over that of the must be deducted from the wine acid, it will show plainly the loss by natural causes, and at the same time show the great decrease in acid, in high-acid and low-ash musts.

Comparing the *ash and acid of the musts*, a certain definite relation seems to exist between them. The amount of acid is usually inversely proportioned to the amount of ash. This does not hold true in all cases, but sufficiently so to establish it as a rule. In accordance with this rule, we must expect to find a low-ash wine to correspond to a high acid must, and vice versa. This is true in the case of all the wines with the exception of Zinfandel, which is also an exception to the above rule concerning must; for the Zinfandel has quite high ash and acid. High ash is usually accompanied by a high per cent of sugar, and with increase of sugar comes a decrease in acid.

Limy soils are apt to produce a small amount of acid. In addition to this, much of mucilaginous substances may be developed which impede fermentation and prolong it to an undesirable extent. The Chasselas are examples of this kind of grape. They produce a large amount of pomace in the white wine variety, consisting largely of these substances; the "red" wine carries more of it from the grape and deposits it in the lees, as is seen by the per cent of organic matter. The Burger and Charbonneau act quite similarly to the Chasselas.

The ashes of 1881 lees are more alkaline than those of 1880, and the musts contain more sugar.

The ash of the early Mission presents an anomalous case. Its must is low in ash, while the wine, both red and white, taken together with the ash of the lees, amount to considerably more than the original ash of the must; the ash of the red wine alone exceeding that of the original must. The apparent increase in ash over that of the must is due to the decrease in volume during fermentation, by the loss in carbonic acid. This loss in some of the sweetest musts is quite considerable. It may not sufficiently account for the great change in the wine just noted, but will account for any apparent discrepancies in the other wines.

MISCELLANEOUS INVESTIGATIONS.

EXAMINATION OF "WASHES" SENT BY MR. T. F. EISEN.

On June eighth I began the analysis of two "washes" sent by Mr. T. F. Eisen, of Fresno. He says: The wash originally contained twelve per cent of saccharine, which I fermented down to six per cent and then turning into an acetic fermentation, I distilled it. The residue of the boiler I drew off (of which the two bottles forwarded are samples) and found it to contain six per cent of sugar. Before fermenting I killed the acetic acid in the "wash." The analyses of the two "washes" below explain the reason of their not fermenting:

	Wash "A."	Wash "B."
Specific gravity	1.022	1.018
Temperature	66 (F)	68 (F)
Sugar by specific gravity (if sugar)	5.5 per cent.	4.3 per cent.
Acid, calculated as tartaric	1.035 per cent.	1.537 per cent.
Ash	1.331 per cent.	

Both of the washes were tested for sugar by the polarization method, and, also, with a copper solution, but neither method gave the slightest indication of its presence. I also made a test for alcohol which might have been left during distillation, but none was found. The residue by specific gravity is put down in the table as sugar, but no sugar exists in it. It is formed mainly by the concentrated extractives of the wine, gummy matters, and the lime used to "kill the acetic acid" before distilling. The large amount of ash shows to what extent alkali was added for naturalizing the acid, still it was added in too small quantity, as is shown by the excess of acid remaining in the wash.

TARTRATE OF LIME PRECIPITATE, FROM MR. CHAS. KRUG, ST. HELENA.

A sample of this crude tartrate, prepared from distillery washes by treatment with lime, was sent to us to determine the amount of tartaric acid.

A test was made for malic acid, but scarcely any was found.

Below is a summary of the analysis:

Moisture, dried at 100° (C.)	12.22 per cent.
Organic matter	50.22 per cent.
Tartaric acid	26.07 per cent.
Ash	38.51 per cent.
Ash (carbonated)	38.62 per cent.
Ash (insoluble carbonated)	38.15 per cent.
Ash (soluble carbonated)	0.47 per cent.
Gums	10.00 per cent.

This product, while available for the production of tartaric acid, would be purified with some difficulty.

On May 14, 1881, we received four other samples of tartar from the same gentleman:

No. 1—Purified tartrate of lime.

No. 2—Tartrate of lime obtained by pressing.

No. 3—Crude tartar, such as separates from washings and residues from distillation.

No. 4—Mash, separated from distillate washings, contains little or no tartrate of lime.

Tartaric acid obtained—No. 1, 43.58 per cent; No. 2, 20.56 per cent; No. 3, 65.33 per cent.

INVESTIGATIONS ON THE PHYLLOXERA MADE AT THE UNIVERSITY.

In addition to the regular laboratory work, a few observations have been made on the growth, changes, and different states in which the phylloxera may be found at different times of the year. No stated time has been set apart for these investigations, and little

or no apparatus has been available for carrying out any set series of experiments. The subject has been taken up during intervals of spare time.

The vineyard from which the specimens were obtained, and in which the observations were made, is on the University grounds. It is small, but contains quite a variety of vines imported from the East and elsewhere. No information can be gathered as to how the phylloxera was introduced into the vineyard, or how long it has been here. Some of the vines have already died, and every vine is infested. There seem to be two spots which indicate the possible starting point of the insects; in these spots the vines are dead, and surrounding them are vines that are gradually failing. There seem to be no varieties that show signs of resistance.

Without attempting to give an elaborate report, I give some of the notes as they were taken at the times of observation.

The first observations were made November 17th, 1881. The insects were found quite numerously just below the surface of the ground, but in less numbers than might be expected. Large numbers were found two inches below the surface of the ground on the Cornucopia and Walter varieties. Above this point none were found, although their root markings were very distinct. Young larva forms were most numerous; old ones few in number. On the twenty-eighth of November I found numerous insects on a small root or spur, just at the surface of the ground, between a root and the stump, and protected by a slight covering of loose dirt. They were not so numerous on other vines. The Rose of Peru is infested with a few scattering insects, while the Wilmot's Black Hamburg is badly infested only on the young roots; the old roots are almost free from insects.

December 8th.—The Cornucopia is still badly infested on the young and fibrous roots, even within two or three inches of the surface of the ground. There are no signs of migration. Some on the main root, near the surface of the ground, were very dormant. Other vines were examined, but few insects were found, and these in groups of five or six near the healthiest parts of the roots. They seem to be diminishing in numbers on the older roots. They are mostly mother insects, and few larvæ.

December 20th.—Three vines were examined, and phylloxera found at all depths, even to the surface of the ground. No portion seemed infested more than another. The Cornucopia is specially productive of the insect, showing bunches at intervals on all parts of the roots; they look like settled colonies. Adult larvæ seem to be the most numerous.

Another examination was made December 31st, but revealed no remarkable change since last visited. The Duchess of Buccleugh was infested with bunches of phylloxera at the base of a spur from last year's sucker. They were just at the surface of the ground, living upon a fresh growth of bark, resembling that of Black Knot. The roots were not infested. A portion of the bark was placed under the microscope, and found to be covered with black "lumps" closely resembling dead phylloxera. Some were turning brown to black; some were small and shriveled; evidently all were suffering or killed by the weather. They were in groups as when alive. Upon warming some of the younger insects by the fire, they soon began to move their legs and antennæ, but their bodies were motionless. One attractive group, apparently of the same generation, formed a row

upon one end of which the insects were blackening and drying up, while on the other end they were lively and moving.

The investigations on January 9th and 28th, February 22d, and March 28th, showed only a decrease in the numbers of phylloxera, and those remaining confined more to the healthiest rootlets and in small bunches. They are becoming dark colored, and move sluggishly.

April 28th.—Up to this time no change has been noticed in the movements or form of the insects. The old ones are beginning to be more active. Scattering eggs are to be found on some of the roots, and some of the hibernating mothers have laid from three to five eggs, very transparent and quite large. Some are turning yellow and are more mature. No very young larva are to be found on the roots, but they were soon (May 1st) hatched out from a bottled specimen taken from the vines at this time. This shows that the dormant mothers began laying about the middle of April. The mother louse seems not to have moved from her winter position.

About this time I examined a bottled root specimen which had been placed in an unsealed fruit jar in the laboratory last December. The specimen was literally covered with the insects, with only a few of the old mothers, and an immense number of young larvæ and eggs. The warm and even temperature of the room is undoubtedly the reason of their earlier activity on this specimen. Near one of the hibernating mothers were fifteen eggs, and egg shells from which the larva had hatched. The eggs were generally small. The brown or red mother insect was still laying, although she was so shriveled up that the banded structure of her body was scarcely distinguishable. Near the one just described was another encircled with eight or ten eggs and shells. At this time of the year they seem to lay very slowly. Other vines were examined May 1st. On some no insects were found; others had but few insects and few eggs.

On May 3d I found very few larvæ on the surface of the roots, but eggs, larvæ, and old ones were numerous under the old bark.

May 18th.—Not many insects on the old roots, but eggs and larvæ are plentiful on the young fibrous roots of this year's growth. Some variety of vines are more affected than others. The insects seem to be of a greener color than they were earlier in the spring.

June 6th.—Vines are all making a good growth; the phylloxera does not seem to be increasing rapidly.

June 21st.—Eggs are numerous, and increasing faster than at any previous time. The spread is not general.

July 13th.—Some of the vines examined to-day were heavily manured last spring. This had produced a vigorous, bushy, fibrous growth, forming a network around the tap-root. In all cases these were very badly infested—largely with the mother lice (evidently of this year's growth), which were then laying. Scarcely any phylloxera can be found on the old roots. The eggs are not so numerous, nor the active larvæ so abundant as on specimens hatched in the laboratory. Among the insects to-day were one or two that closely resembled the wing-pad stage of development. Their antennæ and legs were black. Upon each side, and extending along the body, was a dark spot, covering the rudimentary wings. Some of the fibrous roots were placed in a bottle, similar to other bottled specimens, and remained corked up until July twenty-sixth, when I found a small, live, fertile winged phylloxera, undoubtedly the further development

of the wing-pad insects found on the thirteenth of July. This insect was immediately transferred to a small phial, and before the following morning she had laid an egg and died.

On the twenty-seventh of July I collected more roots from the same part of the vineyard, and found the wing-pad form without difficulty. Upon one root were five undeveloped insects near each other. I now examined one of the old roots which had been bottled a long time, and found upon this specimen a single wing-pad insect. In the afternoon of July twenty-seventh I found four or five winged phylloxera in the specimen bottled July thirteenth. These were also transferred to the same small phial, and by the following morning two had each laid an egg and died. The remaining three were very active, and afterwards laid eggs and died. At least fifty winged insects were taken from this one bottle, and many of the undeveloped ones were destroyed before becoming winged.

In order to watch the development into the winged form, I placed some of the largest undeveloped insects in a glass and covered them with a watch glass. Fortunately I had but a short time to wait, for I had scarcely placed them under the microscope before one of them began shedding its skin preparatory to spreading its wings.

The skin is of a dark color, and sheds off towards the tail of the insect, leaving her antennæ and legs of a very light color. The wings were folded in a light colored bunch directly across the back. They soon part in the middle and then look like two white or light colored sacks. These gradually expand, leaving the apparent casings continually at the end of the wings until its full length is reached, when they begin to spread. The whole casings were merely folded wings.

The newly formed winged phylloxera soon becomes active, and begins walking around. One hour and fifteen minutes from the time the insect was partly out of its skin, it became a perfect winged insect. The skin was shed fifteen minutes after the insect was first noticed. The insect passes from a light to a dark yellow color, during the change, while the wings, when folded, are very light to white, pass to a transparent state, and finally, when old become dark to black.

One of the insects was taken from the moist bottle and placed upon a glass plate. When the moisture had dried from her wings she made several efforts to fly, after bringing her wings together perpendicularly over her back. After several attempts, in which she leaped and flew from two to six inches, she finally flew away.

The work was interrupted at this time until October thirteenth, when the insects were still numerous, eggs plentiful, and the mother lice still laying. Can find no indication of the winged form. Some of the smaller roots are beginning to dry up.

On the seventeenth of November a careful search was made to determine the proportionate number of old insects that were to pass the winter on the roots. Of several specimens that were examined only one contained a fully developed mother louse. The remaining insects were young larva, healthy and quite active; some were blackened and lifeless, still retaining the larva form. Only one egg was found, and that partially developed. The roots were generally badly eaten and knotty, leaving very little surface of fresh bark for the insects to feed upon. The young larva are scattered all over the roots.

December 20th.—None of the mother insects can be found; only larvæ, bright but motionless, are visible.

The tenacity with which this insect clings to life is something remarkable. Often the old root specimens, after they have been properly cared for during the first month, are put aside and left to dry up. Months after they will be found infested if the root is not perfectly dry. A specimen containing one insect was used last July for investigation and then discarded. A few days ago (November seventeenth) it was examined and found badly infested with young larvæ in the same condition as those found on root specimens in the vineyard. No fully developed insects were found. The spot where the original mother insect was, when the specimen was fresh, was marked, and is now swarming with larvæ, while the remainder of the roots contain scattering ones. During the latter part of the time the bottle was uncorked, leaving the root exposed to the air so that it became quite dry.

The condition of the insect during different times of the year may, then, be described as follows: There is a dull, lifeless condition of both larva and mother louse during the winter, lasting until about the middle of April, when the hibernating mothers begin to lay their eggs. The young larvæ soon begin hatching out and scatter to all parts of the roots. The increase is very slow until the middle of June. The winged-form began developing about the first of July. Eggs are most numerous about the last of July or first part of August. The old mother lice are soon found in decreasing numbers, and young larvæ are most abundant. A gradual decrease in the number of insects begins about the first of October. No eggs, or scarcely any, are to be found after this month. Very little action or life is noticeable after November.

INVESTIGATIONS IN THE LABORATORY.

Besides the work just described, a cursory study was made of their changes during propagation. The first difficulty met with was to get the specimen in such a shape that it would not mold and at the same time keep moist. A piece of root containing the required number of insects is placed in a salt-mouthed bottle, supplied with a close fitting cork. If it becomes necessary to remove the cork very often, a few drops of water may be dropped into the bottom of the bottle to supply any lost moisture. By regulating the temperature the water can be vaporized and then condensed so as to supply moisture to all parts of the root. A cool, dark place seems best fitted for their growth. Some specimens were kept in the sunlight and a good circulation of air passed through the bottle, but the insect did not thrive under this treatment. Roots thus treated are harder to keep in condition, and the insect becomes more active and will not remain in the same place.

The leading questions to be determined are:

1. Number of eggs laid by each mother louse.
2. Rate of laying.
3. Time required to hatch them into larvæ.
4. Time from hatching of larvæ to their egg-laying season.
5. Relative number of each kind of insects.
6. Winged form.

First, with regard to the *number of eggs:* Two or three specimens

containing isolated mothers were placed in bottles and observed every few days. The highest number of eggs from any of these insects was about seventy-five. Numerous bottled roots have specimens of sixty to seventy eggs and larvæ together. It is not uncommon to see a nest of forty to fifty in a row, upon one end of which the young larvæ are just hatching out and moving away, while at the other end are newly laid eggs and the old mother, now reduced to a very small, dark colored ball without apparent life or insect shape. This number is not so frequently found in the vineyards.

The most prolific insects do not seem to produce a generation of the numerous egg-laying kind. As soon as the eggs are hatched into larvæ they move away, while those insects producing eggs that are destined to become laying mothers lay but few eggs, which, when hatched, move less rapidly than the other kind, and are often found in groups.

Second—*Rate of laying:* Two isolated mothers were placed in two separate bottles. The first one, existing under favorable conditions, laid, without moving from her original place, about thirty-four eggs in twelve days. In less than four weeks the entire generation had left the spot, and no trace of them could be found. The other insect, under less fortunate circumstances, was near the bottom of the bottle, and was kept very wet. Part of the time a meniscus of water surrounded and almost submerged her. During the first few days she laid only one egg daily. At the end of twelve days she had laid twenty eggs, and continued laying about four weeks. Toward her last days she would lay one egg in two to four days. One old mother insect laid sixty eggs; thirty-five of the number were laid in seven days. Another laid fifteen eggs in four days. The rate of laying is therefore very irregular; sometimes five are laid in a day; at other times days pass without any being laid.

Third—*Time required to hatch the eggs:* This is hard to determine unless very carefully watched. In one of the specimens noted above, a young larva emerged from under the pile of eggs thirteen days after the first egg was laid. I began June thirteenth with two specimens of single phylloxera. The first eggs were laid June fourteenth. On July seventh I could distinguish some of the young egg-laying variety which had hatched out some time before. One of these young ones began laying July fourteenth, and by the following day three eggs had been laid. On July twenty-first another of the same generation began laying. The old mother louse continued laying until July twenty-seventh. She is the same one that laid forty eggs, and was under water June thirteenth. About thirteen days was, therefore, required to hatch the eggs.

Fourth—*Age of the egg-laying larva:* If we deduct thirteen days from the total number of days which passed from the time of first egg-laying to the time of the next generation's egg-laying, we have the length of the larva state. In the case cited above, it lasted about thirty days. In another case a few young larvæ were hatched out June twelfth, at which time only one family inhabited the root; on July twelfth there were three distinct families with from three to eight eggs apiece, showing that less than thirty days is required for the production of a second generation from a single egg.

Fifth—*Relative number of each kind of insects:* Little or nothing can be said on this point. The hibernating mother produces a generation of insects which all develop into a very active young larvæ,

and all of them will leave the spot as soon as the eggs are hatched. Or, in some cases a very few remain behind in a very inactive state and are destined to become mothers. It is also noticeable that the large broods are more apt to be of the active kind; furthermore, if those large broods were to develop into egg-laying kind we would find numerous egg-laying mothers soon after the scattering of larva takes place; this is scarcely ever seen. With the active kind, the eggs are laid rapidly and in large numbers; the other kind lay but few eggs and usually scattering, one half dozen in a place. I have had single specimens of the active kind, which, apparently, never began reproducing, for no groups of eggs were found on the specimen afterwards. If they are reproductive, then only a few ever live to that egg-laying period, for the bunches of eggs are not numerous even on one of the worst-infested specimens. The egg-laying kind more frequently forms colonies and soon increases to settlements of several families. In the vineyard one may find the roots, along each crack, filled with the old ones, but they do not seem to be laying. In speaking of the two kinds a single case will show what is meant.

One specimen developed four larvæ at the beginning of the hatching period; one of them was long and had the general appearance of the mother; the others were shorter, more elliptical and active; the former is destined to become a resident egg-laying mother, the others will soon scatter. I have kept other specimens of these elongated insects which become egg-laying. I have seen very few insects that answer the description of the male insect, and these mostly among the second generation. They are very sluggish and very seldom move from their first position.

The old mother will live during the egg-laying season from forty to fifty days. During the last part of her existence she lays very few eggs; sometimes several days will pass without laying. She finally becomes a small, almost shapeless ball, losing entirely the original form, turns black and disappears. She often revives to lay the final egg after becoming dark colored.

Sixth—*Winged form*: I have not been able to develop one of this kind from a single isolated insect or upon specimens put away in the earlier part of the season. On the first of July I noticed a peculiar long phylloxera with a black spot on each side, which I concluded were rudimentary wings. I had never seen them before and was not positive that it was really of that kind. Since having developed them later from fresh root specimens, I now think there can be no doubt of the identity of the one noticed July first. The insect was found on a root which had developed numerous large females, and was marked by the number of quiet egg-laying insects. The eggs were scattering. It is generally known that the winged form is abroad and has been found in two vineyards, at least, outside of our vineyard at the University. Careful search will no doubt reveal it in many other places during the coming season, about the last of August.

It is a noticeable fact that only a few vines in a vineyard will produce this variety. Of the large number of specimens that I have had bottled from different vines, only two or three have developed the winged form, and only one of these specimens produced them in abundance. In looking for them in the vineyard, if *one* is found, there is not much difficulty in finding others on the same vine.

ACTION OF CARBON BISULPHIDE VAPOR UPON THE PHYLLOXERA.

A few experiments were made to show the effects of carbon bisulphide vapor upon the phylloxera. A portion of a fresh root, upon which the insects could be plainly seen, and would therefore be freely exposed to the action of the sulphide, was suspended in the center of a glass-stoppered bottle of five and one half litres capacity. Into this bottle were injected, for the different experiments, quantities of sulphide varying from five cubic centimetres to five drops. The intervals of time were fifteen, thirty, and sixty minutes. It was first shown that about four cubic centimetres of the liquid was the maximum amount that would vaporize in the bottle at a temperature of 60° F., showing that the atmosphere in the first experiments was saturated. The temperature remained at about 61° F., in all cases except the last two, when it rose to 65° F.

In the accompanying table will be seen the amount of sulphide used, the intervals of time, and remarks upon each experiment:

Time.	Amount used.	Condition of Insects.
15 min.	5 C. C.	No signs of life; color slightly changed.
30 min.	5 C. C.	All dead; dark colored and slightly dried or withered.
60 min.	5 C. C.	Dead, dried, and almost shapeless.
15 min.	2.5 C. C.	No signs of motion, healthy appearance, color good, generally not much affected.
30 min.	2.5 C. C.	Healthy appearance, but no motion.
60 min.	2.5 C. C.	No life; darker color.
15 min.	25 drops.	No signs of life; color good.
60 min.	25 drops.	All dead.
15 min.	10 drops.	None dead; nearly all moved.
60 min.	10 drops.	Killed them, but not quickly.
15 min.	5 drops.	Large number died and dried up.
60 min.	5 drops.	All killed; none moved away.
15 min.	5 drops.	Almost all stupified.
60 min.	5 drops.	Some were killed; large numbers unaffected.

The observations noted in the table were made immediately after the specimens were taken from the bottle. In some cases, where the insects are noted as having no signs of life, or as stupified, later observations showed them generally to have been dead. The general effect seems to be, first, to stupify; then follows a change in color, and, if the sulphide atmosphere be strong enough, a quick withering and drying up. The insects treated fifteen minutes with two and one half cubic centimetres remained bright; the eyes and all parts of the body could be plainly seen, and seemed but little affected. Three days later no signs of life could be observed; those treated the shortest time kept their color best. None of them moved after the treatment. In the short treatment with ten drops only two could crawl although each individual could move its legs freely. Twenty minutes later none moved; they were lying in all possible positions, some apparently dead. In only one case (twenty-five drops for fifteen minutes) were there any eggs; these remained bright until after the fifth day; by the eighth day they had dried up and disappeared. It is very noticeable that many of the insects at the end of the treatment seem lively, but during the course of a few hours they become motionless and soon die. In the last experiment, where only a few

were killed immediately, a large number were dead on the following morning.

EXPERIMENTS IN DISINFECTING GRAPEVINE CUTTINGS.

A short series of experiments was made to test the effects of carbon bisulphide and copper sulphate (bluestone) upon cuttings. The cuttings were treated with these disinfectants for varying lengths of time, and then planted in a light soil suitable for the purpose of rooting, and watered once during the season. The results, as will be seen, were very decided in character.

The experiments with the carbon bisulphide were performed in a tight box, of 7.06 cubic feet capacity, in which enough of the disinfectant was placed to produce a saturated atmosphere at 59° F. temperature. It was found that 27 cubic centimetres of the liquid would evaporate in about four hours. This amount was accordingly used for intervals of time equal to, and less than four hours; while for intervals greater than this a proportionately larger amount was used.

In the six and first 12-hour interval, 40 cubic centimetres were necessary. The intervals of time were one, two, four, six, and twelve hours; the last experiment was repeated with a renewal of the sulphide every four hours.

All the cuttings used in these experiments seemed to be unaffected by the treatment, as over ninety-five per cent of them sprouted and grew. It thus appears that exposure to a *saturated* atmosphere of carbon bisulphide, which in the preceding experiments was shown to kill both the living insects and the eggs within less than an hour, does not affect the vitality of cuttings injuriously, even if the exposure be continued for twelve hours. This method, therefore, offers ample security for complete disinfection, and is certainly one of the easiest of execution, since the cuttings can be treated in any fairly tight packing box by using a large excess of the bisulphide.

In the experiments with copper sulphate (bluestone) the cuttings were placed in a solution made by dissolving one part of the crystallized salt in ten parts, by weight, of water, and allowing them to remain during varying intervals of time. The intervals chosen were fifteen, thirty, and sixty minutes. Two sets of experiments were made, differing only in this: that in one set the cuttings were rinsed in water to remove the surplus of the copper solution.

The results were the same in either case. In a large number of them the buds never swelled at all. In others the buds swelled and seemed ready to open, but did so in a few cases only, some developing from one to three puny leaves; but ultimately all died, though treated precisely like the batch that had been subjected to the bisulphide treatment, being in a row 12 inches from the latter.

These experiments prove that the use of bluestone solution of this or any similar strength greatly endangers the vitality of vine cuttings, and it may gravely be questioned that a solution of any strength, certain to kill the eggs of the phylloxera, can be employed for disinfection without causing the loss of a large percentage of cuttings.

ARI